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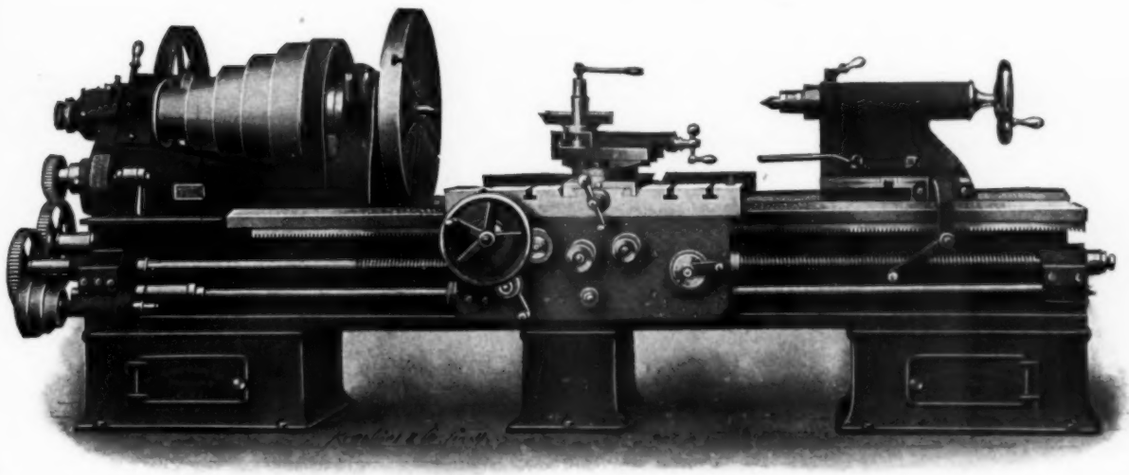

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A New Grinder for Rapid Internal Work

The Result of Many Years of Experience and Practical Study of Grinding Conditions as Worked out by the Bath Grinder Company

EDITORIAL CORRESPONDENCE

The main difficulty with internal grinding is the proper supporting of the wheel against the work which means the avoiding of overhanging parts, of slides and spindle so far as possible. Any moving slide is loose to a certain extent, and this play or movement multiplies as the joints increase.

In the new Bath internal grinding machine the wheel or spindle heads do not move after being properly adjusted, but are locked rigidly to the two long, narrow bearings in place of one wide one as is usually done. These slides are at an angle of about 45 degrees and have the gib at the bottom. This means that they always hang from the upper edge, and in locking are simply drawn tight against this upper edge, not being lifted or pulled up against the lower edge as would be the case were the gibs at the top. The plan adopted gives a solid, rigid contact at all times, and the alinement is not changed by clamping.

This machine is the development of a long series of experiments on internal grinding and is the result of long years of experience and careful study by the designer, John Bath, of the Bath Grinder Company, Fitchburg, Mass. As can be seen from the general design of the machine, it is extremely rigid in construction, having a substantial base and a supporting arm on each side for carrying the grinding head. The right-hand head is fixed, while the other is mounted on a long, rigid slide, and can be adjusted to any position within the range allowed by the drum driving the grinding spindle.

The grinding head and its support are a good example of the attention that has been paid to rigidity, all bearing surfaces being long and very closely fitted, in addition to having sufficient metal to absorb as much vibration as possible. Each grinding spindle is carried in two large taper bronze bearings, supported in the head shown, and this head has double slides, each having a long, narrow bearing to insure all adjustments being square and in line with the table travel. Details of this may be found at *B*, Fig. 6. Each head has an independent feeding mechanism. This feeding mechanism is of the same design as is used for the cross-feed of the table, and will be explained in detail later. It allows each grinding wheel to be fed into the work differently if desired and stops each when the proper amount of metal has been removed, or the desired diameter obtained. In addition to this, each wheel is provided with a sizing diamond, which prevents the hole being ground too large by cutting away the grinding wheel when it has been fed in the proper distance.

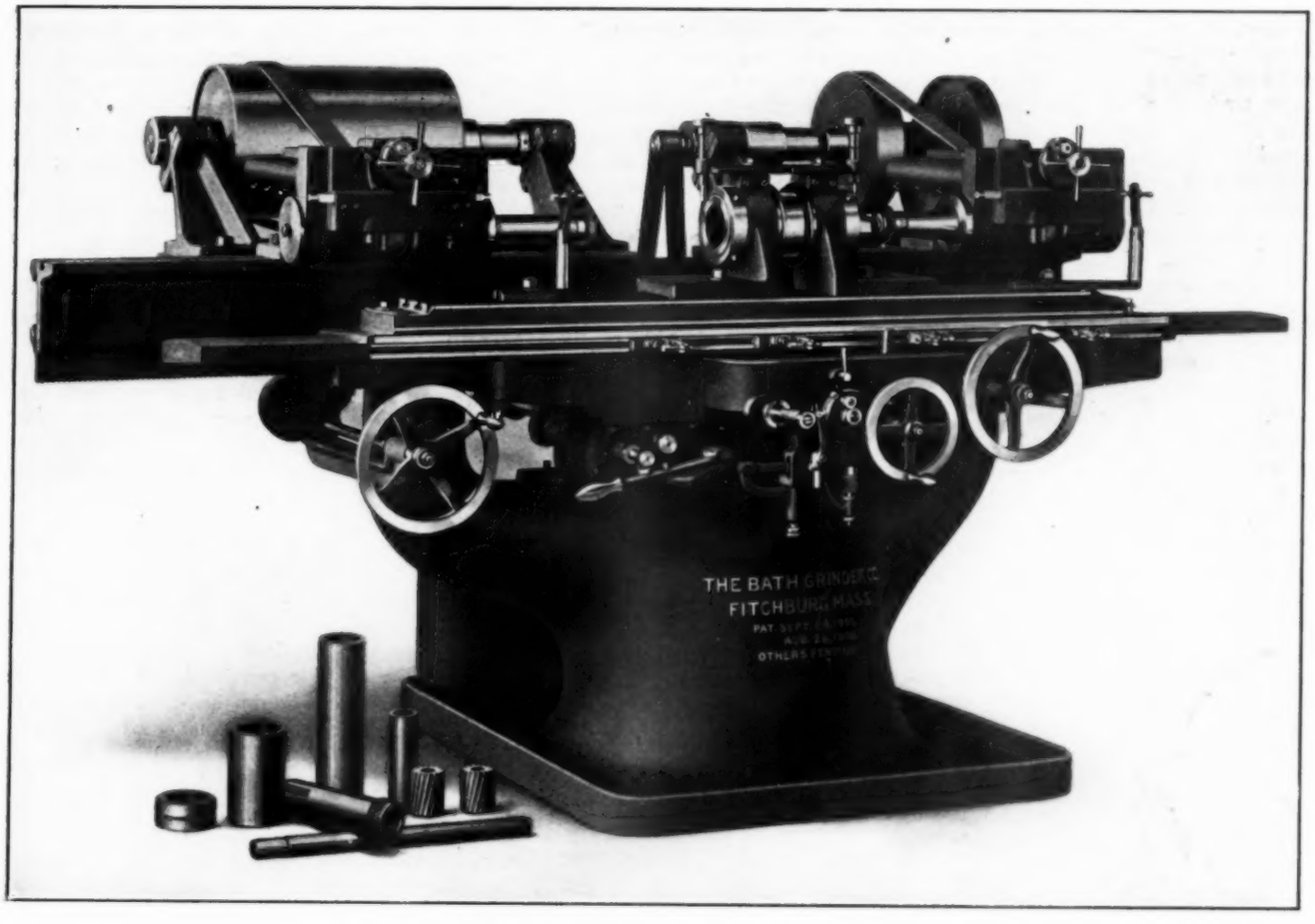

FIG. 1. BATH DOUBLE-HEAD INTERNAL GRINDER WITH QUILL CHUCK

Absorbing the Vibration

In supporting the work for internal grinding Mr. Bath has departed considerably from former practice and provides a large substantial quill, supported in two

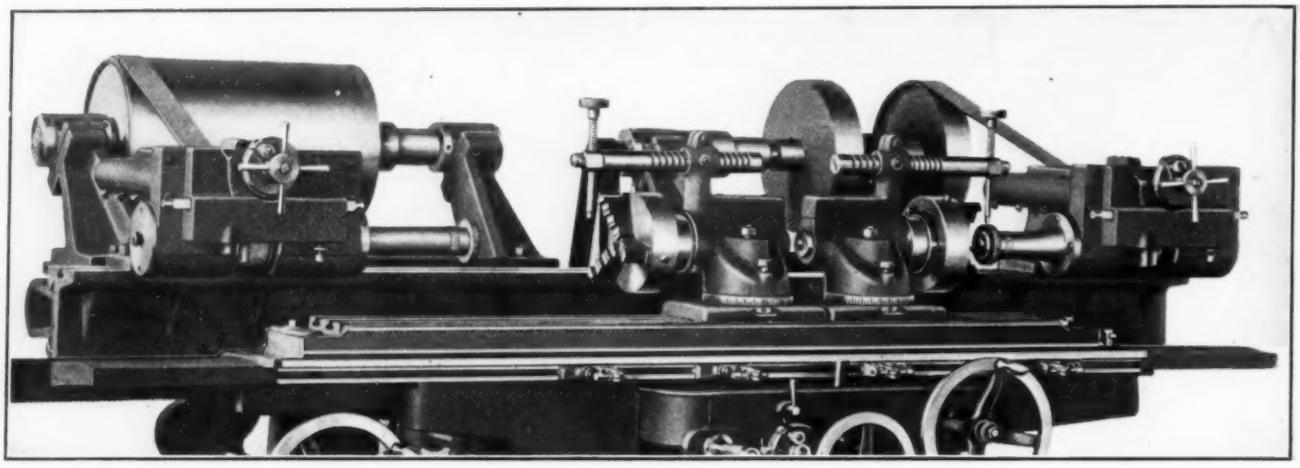

FIG. 2. USED AS A DOUBLE-HEAD GRINDER WITH TWO WORK HOLDING HEADS

large bearings, so that the work can, in most cases, be entirely surrounded by the supporting quill, instead of projecting a long distance from a chuck and being held at one end. This substantial support tends to absorb the vibration, and the result obtained in grinding with this machine seems to indicate that it is holding the work with extreme rigidity. This quill is supplied with either chuck or face plate and allows of considerable ingenuity in the method of holding the work. It is driven by an independent belt from a variable speed counter, so that the work may be revolved fast or slow as seems best for the case in hand.

The cross-feeding mechanism of both the table and head is shown in Figs. 7 and 11, in which it will be seen that the table dogs trip the stop lever *A* and throw it so that the V-shaped projection *B* forces down the roller and plunger *C* and with it the lever *D*, to which is connected the feed lever and pawl *E*, acting directly on the fine-tooth ratchet which controls the cross-feed screw. The amount of feed depends on the distance *D* is moved, and this is regulated by the adjusting screw shown at the end of the lever under the plunger. In the cross-feed for the heads, the only modification is that the tripping bar *B*, Fig. 4, is moved by a raised stop fastened to the table, and acts on the feed screw through the lever *D* without the aid of a plunger in this case. An interesting detail of construction is the nut *N* on the cross-feed screw, which consists of three soft-metal pieces threaded to suit the screw and held in position by the set screw shown. This allows them to always be kept in close contact with the feed screw and do away with any lost motion which might occur in a full nut as regularly constructed. The screw disk is divided for micrometer graduations and has the stop which is readily moved to any desired position by the small pinion working on a central gear. The graduations show quarter thousandths.

Another interesting feature of the table feed mechanism is the automatic throw-out, which is controlled by handle *T*, Fig. 10. This handle also allows the operator to move the table in either direction by power, depending on which way it is thrown. The outer handle is loose and contains the pins *P* on the inside of the collar, Fig. 8, and has a bayonet-joint connection, so that it can be held in its outer position, or can be left free to move in and out under action of the internal spring. When turned so that the pin *Q* has free play in the long slot, the handle automatically stops in the central position, the pin *P* seating in holes in the carriage frame, and holding the clutch *R* out of engagement in both directions. This does away with the necessity of care or skill on the part of the operator to stop the machine at the end of the travel, for measurement or other purposes.

Six rates of table feed are provided by a cone of gears, which are controlled by a sliding key on the rod *S*, and these give a table travel of from 2 to 12 feet per minute, as desired.

The Supported Spindle

On long work that is open at both ends Mr. Bath uses a very ingenious supported spindle, which allows long and comparatively small holes to be ground at a much faster rate than has hitherto been deemed possible. One or more wheels are mounted on a short arbor, as shown at *A*, Fig. 6. By spacing these in accordance with the length of the bushing being ground, three wheels are at work in place of one, and the work is done in proportionately less time. These can be driven from either head, the right in this case, by means of the sectional spindle mounted in substantial bearings. This construction largely

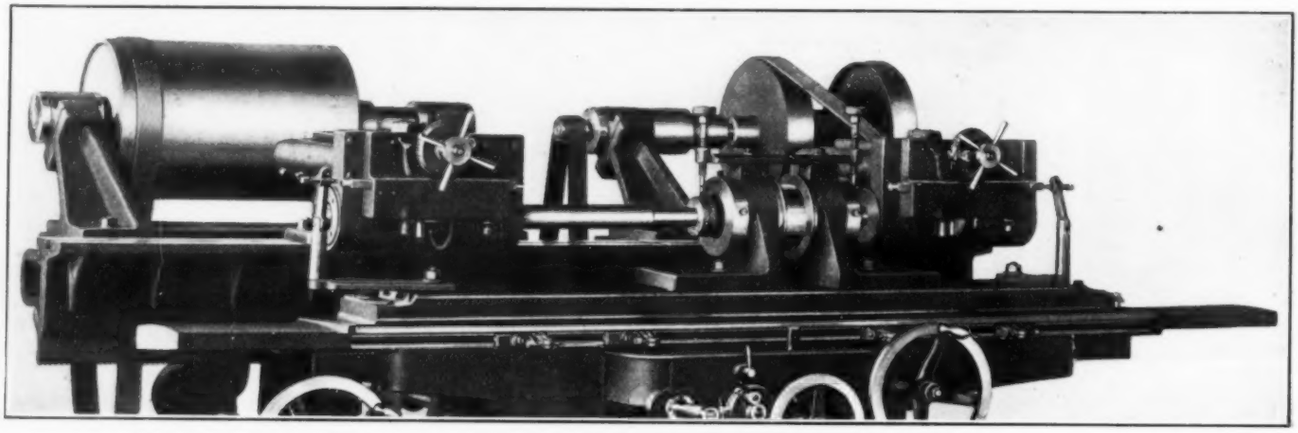

FIG. 3. INTERNAL GRINDER WITH SUPPORTED SPINDLE

does away with any springing of the spindle itself, due to heating, and adds to the accuracy of the work.

The outer end of the wheel arbor has a small projection, which is a good fit into a supporting spindle held in the other head, as seen at *B* and *C*. This spindle runs in bearings very similar to the driving spindle, and by revolving this at the same speed there is no wear on the projection of the wheel arbor, the wear being transferred to the large bearings of the supporting spindle. It is evident that if the supporting spindle is revolved at the same speed as the driving spindle there will be no motion, and consequently no wear on the small end of the wheel arbor, and by varying the speed of the supporting spindle with relation to the driving spindle, any desired distribution of the wear between the two bearings can be secured.

At *D* is a piece being ground from each end, of varying diameters and practically two separate jobs. This avoids the necessity of reversing the work, saves much time and insures the two holes being in line with each other. At *E* two independent wheels, one on each spindle, are at work on the same piece. One can rough and the other finish as the feed of each head is entirely independent. *F* shows the details of the mill for driving the work, while *G* gives an idea of the construction of the single-end spindle. It runs in a rigidly constructed support or bushing, with a large substantial base to absorb vibration. This spindle, as with all the others, is driven by a tang to avoid springing from heating.

Some of the other interesting features of this internal grinding machine are the various combinations of wheels which can be used either as two almost independent machines, or both wheels being used on opposite ends of the same piece.

Four or more table dogs are employed to act as stops in grinding to shoulders, or any similar work, as any of the dogs can instantly be turned up out of the way as soon as one part of the work is done, and the table immediately travels to the next dog and reverses at the proper place for the next diameter of work. Traveling diamonds are employed, so that the grinding wheel may be kept perfectly true at all times and without stopping to rig up a special fixture for this purpose.

As shown in Fig. 2 two independent heads are used for holding work, so that it practically gives two machines when short work is to be ground.

From this it will be seen that long or short holes can be readily ground, that these can be straight or taper, that a sleeve full of washers can be ground as readily as a solid bushing, and that many other uses can be found for it. When the single-end spindles are used the wheel is fed into the work, but with the supported bar in use the wheel slides are locked and the cross-feed in front of the machine comes into play. The three cross-feeds, one for each spindle and for the whole table, make it practically a double machine, which has the advantage over the single spindle on a large variety of work.

Another equipment of the regular grinder is shown in Fig. 5 where two heads are fitted to the table, each carrying a face plate or magnetic chuck, and especially designed for grinding disk and piston rings. This utilizes both wheels at once, and if found desirable on certain classes of work one wheel can be used for roughing and the other for finishing. There is a large variety of work which can be done on fixtures of this kind, and as each head is independent of the other, any desired adjustment or variation can be secured.

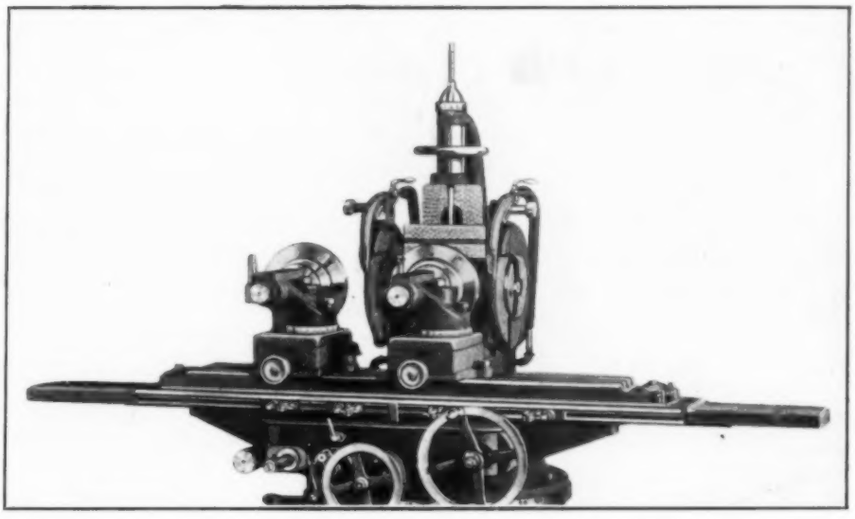

FIG. 5. TWO HEADS MOUNTED AS A DISK OR RING GRINDER

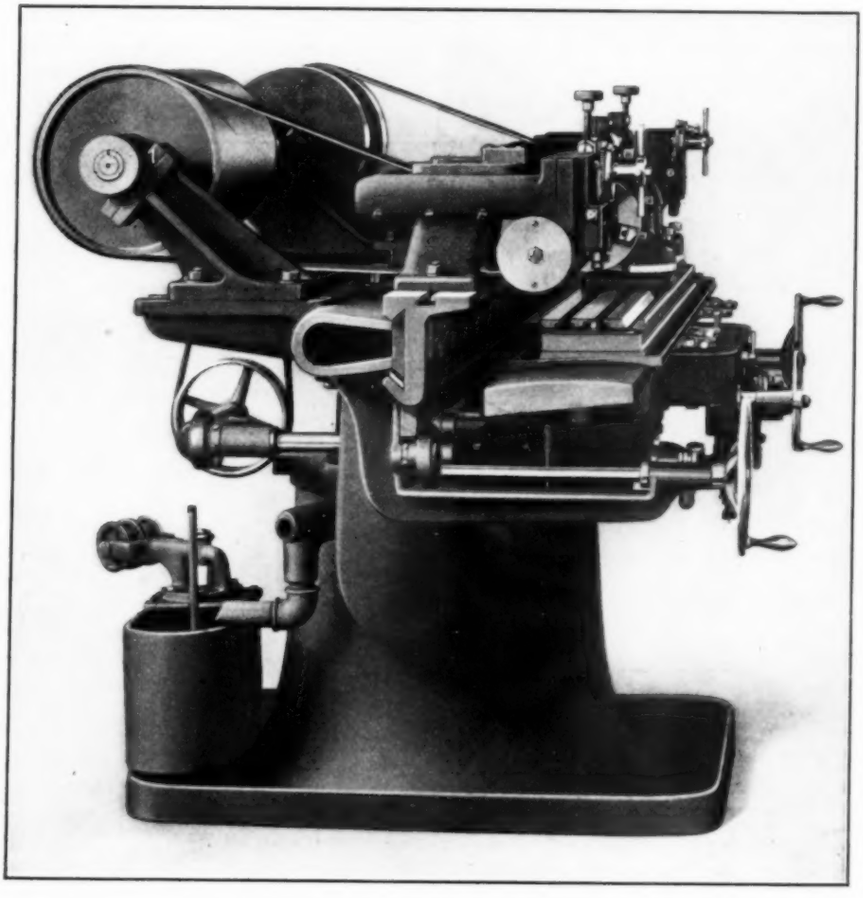

FIG. 4. END VIEW OF INTERNAL GRINDER

Some of the Work Done

Those of us who remember when internal grinding consisted more in a small display of fireworks than in the actual re-

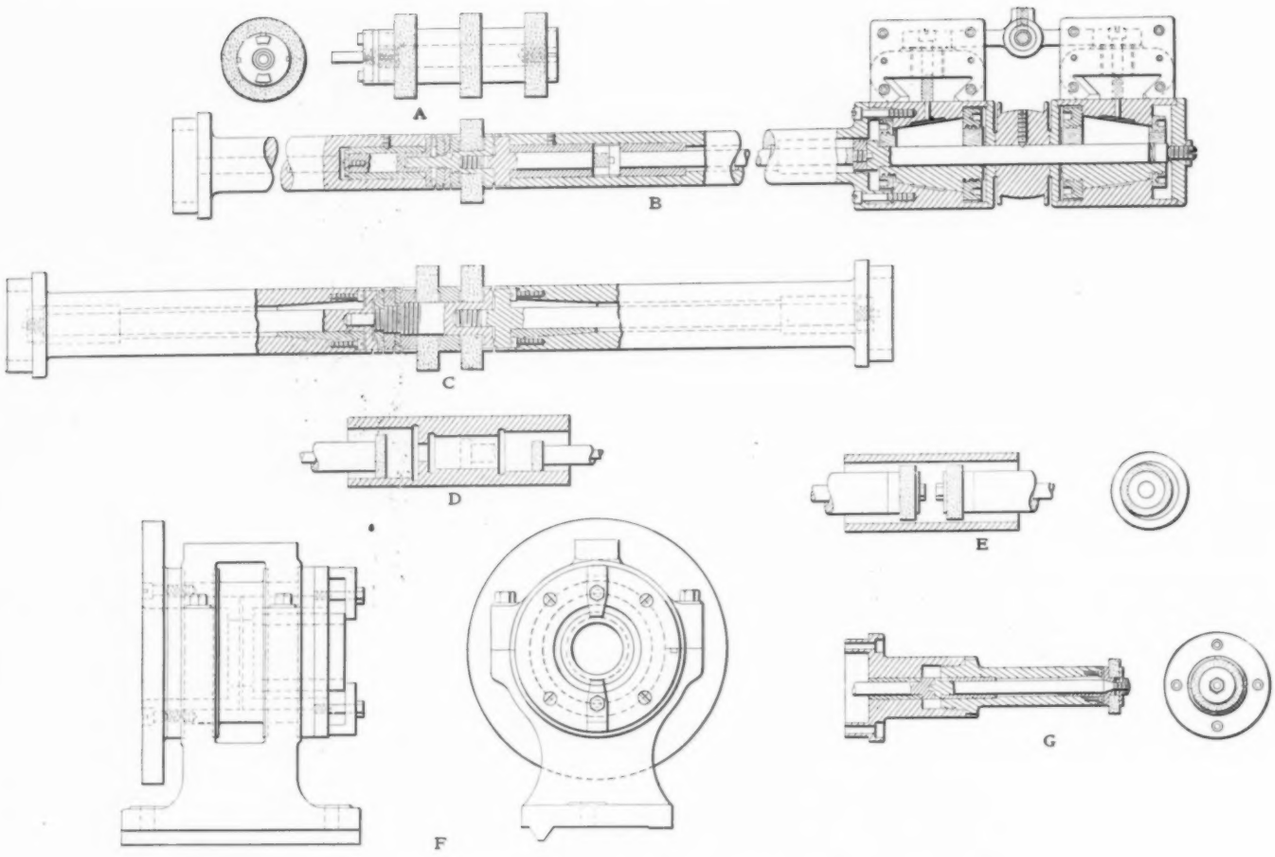

FIG. 6. CONSTRUCTION OF SUPPORTED AND SINGLE SPINDLES, AND HEAD

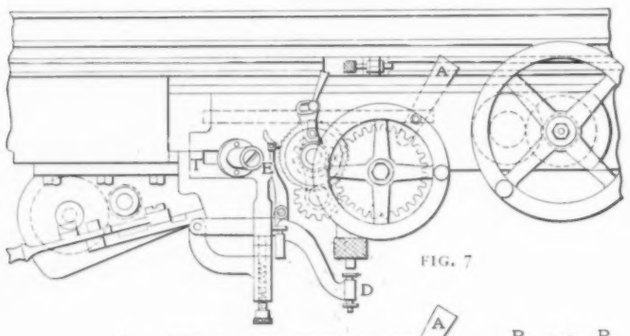

FIG. 7

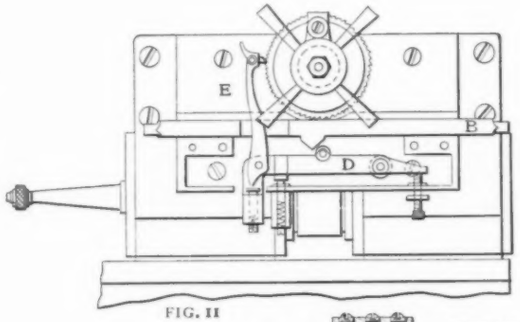

FIG. 11

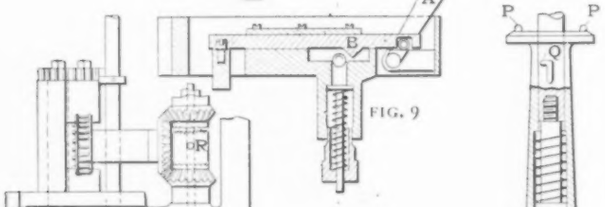

FIG. 9

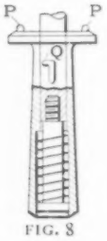

FIG. 8

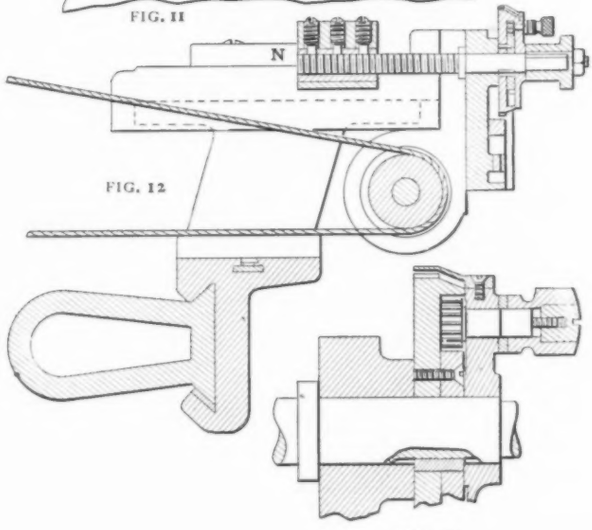

FIG. 12

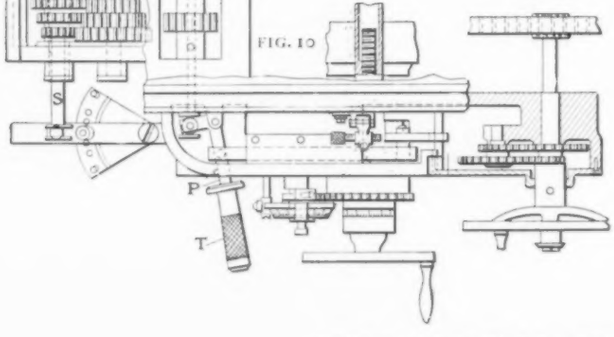

FIG. 10

FIG. 13

SOME OF THE DETAILS OF CROSS AND LONGITUDINAL FEEDS

moval of much metal, will be astonished at the work done by this machine. The substantial design of both machine and spindle, together with the use of large grinding wheels and ample supports for the work to be ground, enable grinding to be done which has often been considered impossible. An examination of the cutting under even a low-power glass shows them to be actual chips instead of small particles ground off, and some of the following tests give an idea of the rapidity with which stock may be removed in this way: On a cast-iron bushing 12 inches long, 3¾ inches in diameter, the bore was enlarged 1/32 of an inch in 5 minutes, and a round hole of uniform diameter was the result. This was done with a supported spindle and using two 3½-inch wheels with ¾-inch face.

With single-end spindles, a steel bushing 6½ inches long with a hole 3¼ inches in diameter was enlarged 0.018 inch in 5 minutes. A phosphor-bronze bushing 2½ inches long, 3½-inch hole was enlarged 0.10 inch in 5 minutes.

Another feature that is a departure in internal grinding is the use of wheels as large as can be run in the hole being ground. This is made possible by the amount of power available, and as a result, the machine does more work in the same time, as more cutting points are at work in much the same way as the use of several lathe tools insure a larger production. This, in connection with the use of two or three wheels at a time, is largely responsible for the result obtained.

The machine uses an average of 2½ horsepower when at work on heavy grinding, and runs at 7500 revolutions per minute, giving it an enormous cutting capacity.

A New Steel

The suggestion made by Professor Arnold at the recent meeting of the Royal Institution of Great Britain has attained actuality sooner than was anticipated. The professor stated that, speaking on specific facts within his knowledge, he was strongly of opinion that the best high-speed steel of to-day was destined to be superseded, and that he thought it probable a year hence there would be on the market a British steel with quadruple the cutting power of any now known to metallurgy. This naturally caused intense excitement among steel manufacturers, and in Sheffield created a feeling little short of consternation. Inquiries among the four or five present makers showed that the announcement was received with a considerable amount of incredulity. On Wednesday, however, the secret was out, and it was announced that Messrs. Jonas and Colver, of the Continental Steel Works, had discovered a new steel, which, in the opinion of experts, fully justified the encomiums of the professor.

Messrs. Jonas and Colver state that the steel, as a matter of fact, is already on the market, and that samples have been in the hands of travelers of the firm since the beginning of the year. Rigorous tests have been made, and the steel has undoubtedly more than quadrupled the efficiency of any existing steel of a similar type.

The history of the research leading up to the discovery of the new steel has peculiar interest. When the litigation with the Bethlehem Company of America—which has since ended in a defeat for the makers over the water—was entered upon, Messrs. Jonas and Colver set themselves to consider how to maintain their position if the judgment of the American courts should shut out high-speed steel made under the prevailing conditions. When high-speed steel was first produced it was water-hardened, but a subsequent improvement resulted in water-hardening being changed for air-blast hardening. It was through this latter feature that Sheffield makers found themselves in conflict with the reported American patents.

Experiments were conducted at the Continental Steel Works for a period extending over six months, and the result was the production of a new steel which was hardened in water, and which showed a remarkable increase in hardness over the present existing high-speed steel. The firm was thus placed in a position independent of the result of the American litigation. The new steel can be annealed; no modern high-speed steel, in fact, has any advantage over it in the matters of annealing, forging, and over-heating. An interesting experiment recently conducted by the makers showed that a tool made from the steel could be hardened seventeen consecutive times in cold water without showing any signs of a crack.

Interviewed on the subject, B. W. Winder, director and works manager of the company, said that the new steel was in no way calculated to call for any alteration on the part of machinery. The idea had been to produce steel that would last longer at the same speed, feeds, etc. In forming cutters, for instance, it was only the edge of the tool which the engineer really purchased, as when this was worn even the fiftieth part of an inch the tool was no good, and required sharpening. The wearing quality of the cutter was therefore of vital importance. The new steel would harden perfectly in water, but could also be hardened in oil, paraffin, or even blast. It could be used by anyone accustomed to work with high-speed steels. As to the cutting power, it was difficult to give comparative results, as so much depended on the quality of material. On very mild steels it would probably do two or three times as much as the present tool steel. On a hard material very much better results were achieved, sometimes as much as six or seven times what customers were getting out of ordinary high-speed steel. Mr. Winder instanced a tool made out of the existing high-speed steel, which, working on a very hard material, had to be ground at least five times a day. Last week a similar cutter made from the new steel was put on. It worked a day and a half with one grinding, and the report that morning was that it was going on very well indeed. In such machines as turret-lathes, he pointed out, the new steel would prove invaluable, as these were often fitted with a dozen tools on one turret, and the breaking down of any one of these necessitated the stoppage of the whole work until it was replaced. As to comparative cost, Mr. Winder preferred to say nothing, although, of course, he admitted the new steel was more expensive than the existing material.

Professor Arnold, interviewed subsequently, said he maintained the views expressed at the Institution, that there was no comparison between the cutting powers of the new and the present high-speed steels. He was only interested in the matter from a scientific point of view, but to a scientific man the phenomena exhibited by this steel formed an intensely interesting field for investigation. It was an absolute departure in metallurgy to have obtained a water-quenched steel with the cutting edge of the tool a bright red glow when cutting very hard material. This steel, and the experiments leading up to it, had been under his notice for a lengthened period. Of course, it was possible to exaggerate the importance of the matter to the steel industry, owing to the comparatively small quantity of high-speed steel used, compared with ordinary carbon steel, but it marked a notable advance. The secret, of course, could not always be kept, and he believed that three years hence every high-speed steel manufacturer in the country would be making this steel.—*Engineering.*

[This new steel has been named "Novo Superior," as already noted on page 241.—Ed.]

Of all classes of manufactures exported from the United Kingdom in 1908, machinery was the least affected adversely, as a decrease of only $3,621,652 in a total export of $150,955,538 attests. This bears evidence of the vast foreign development in agriculture, mining, railways, textile industries, etc., which seem not to have been affected to any great degree by the general depression attributed to the financial disturbances in the United States in 1907. It is reported that the exports of British textile machinery in 1908 show an increase of $4,000,000 as compared with 1907.

The Methods of Modern Tack Making

The Way in Which Material Is Selected and the Interesting Machinery Which Turns out from 300 to 2000 Tacks Per Minute

EDITORIAL CORRESPONDENCE

Among the interesting examples of what may perhaps be called minor industries is that of making tacks, which includes all kinds from the smallest gimp to the very large ones with a business end of decidedly large proportions.

The steel comes in sheets and must be selected to have the required stiffness for driving into hardwood floors in some cases, the malleability to allow for the upsetting of the large head and the strength and toughness to prevent the cuss words which are often occasioned by having the head pull off.

The sheet steel comes in bundles from the mill and goes, first of all, to the pickling bath to remove the hard scale on the outside. The bundles are opened, the sheets separated by metal clips and placed in a cradle, as shown in Fig. 1. The two side or end pieces of this lie out flat on the floor until the cradle has been loaded. Then the ends are brought up, as shown, which holds the sheets in place and allows the crane hook to take hold.

Over the tank is a runway or trolley track on which the hoist runs, and a few turns of the wheel serve to lift the cradleful of sheets so as to clear the edge of

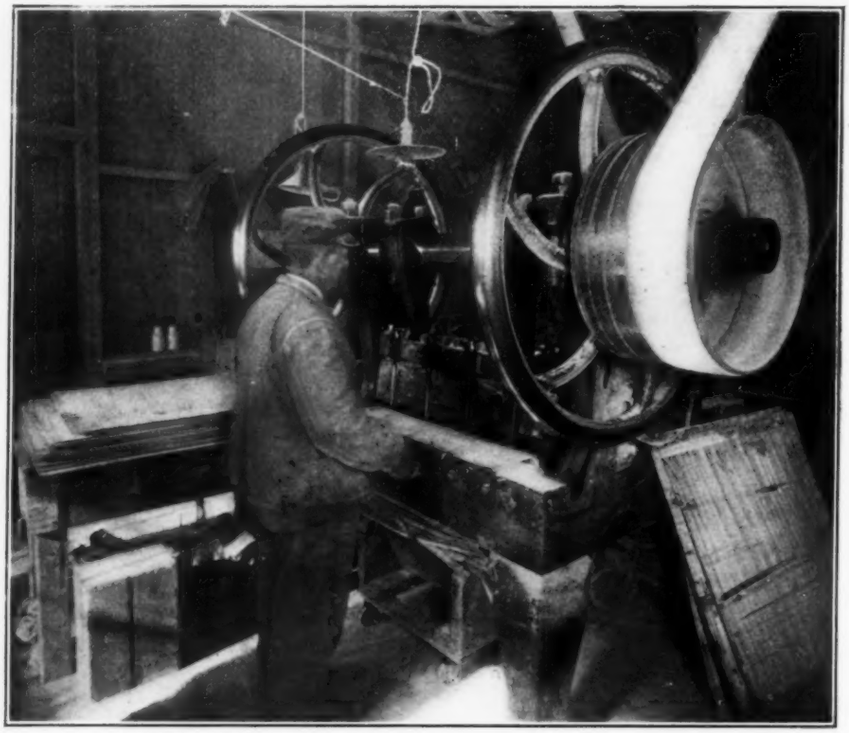

FIG. 3. SHEARING OR SLITTING THE SHEETS

FIG. 1. THE PICKLING BATH

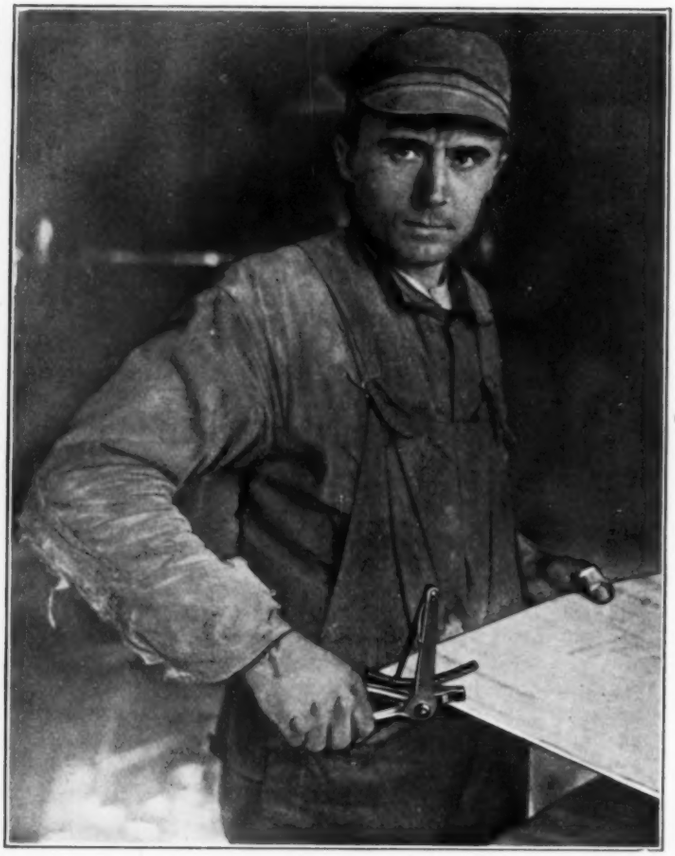

FIG. 2. GAGING THE SHEETS

the tank, and it is then run over the acid tank which is in the foreground. This contains a very dilute solution of sulphuric acid into which the plates are dipped for perhaps 20 minutes, after which they are hoisted out and carried along to a fresh-water tank provided with circulating water so as to get rid of the sulphuric acid after it has eaten away the hard outside scale. After the rinsing it goes to a third tank containing limewater in saturated solution, and a dipping here gives it a light coating of lime, which effectually prevents rusting from either the acid or the water.

A Novel Inspection Gage

The sheets are now ready to be inspected for thickness, which is being done in Fig. 2. The inspector has what might be called an indicating micrometer, although it looks a cross between a belt punch and a mariner's sextant. In reality it is an exceedingly clever and convenient instrument, consisting of a pair of jaws something like a pair of pliers, but having these jaws connected with a sensitive multiplying lever, swinging over quite a large arc which is graduated in two ways. On one side of a center line are marks indicating the correct thickness of the various gages which are used in making tacks. On the other side of this center line are graduations which read to thousandths of an inch. In operation the jaws are pressed on the sheet to be measured and the inspector watches the pointer on the scale. If it stops at the required gage number the sheet is passed for this thickness, and if it is not exactly right, the graduations on the other side of the center line show how many thousandths it is out one way or the other. This allows very close sorting of the sheets, and at the same time allows them to be handled very rapidly, as can be imagined.

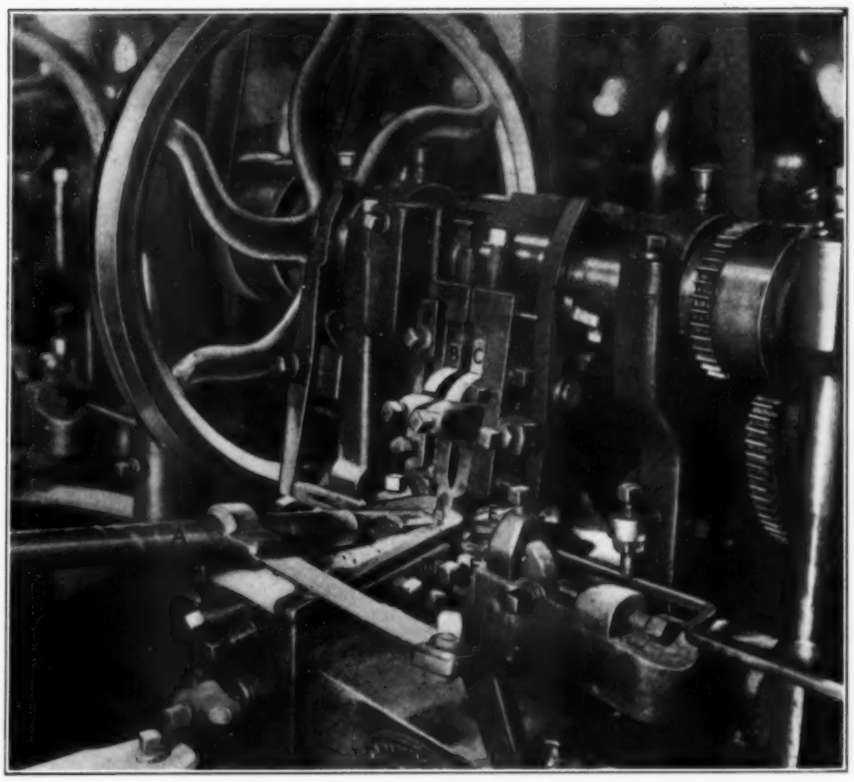

FIG. 5. THE TACK MACHINE AT CLOSE RANGE

The next operation is the slitting or shearing of the sheets into strips of the required width, as the width must allow for the proper length of shank and also material for upsetting the head. The shearing or slitting machines are shown in Fig. 3, which shears the whole width at one stroke, the sheets being held in place by the four spring plungers shown in front of the blade. This press runs about 130 revolutions per minute and cuts up the strips at such a rapid rate that it takes practice to feed the sheet in against the stop every time.

From here they go to the limit gages, shown in Fig. 4, which afford a rapid means of final inspection and detect variations in thickness of the same sheet. Although it is comparatively crude, it answers the purpose admirably, and is an application of the limit principle in a class of work where it would hardly be expected. The strips which fail to pass between the first set of points are laid in front; those which go through the first set but not the second go in the first depression, and so on to the end. The smallest ones, which pass through the last set of points go into a special pile. In this way it is possible to sort the strips so as to secure great uniformity, which adds to the uniform working and consequently the output of the tack machines themselves.

FIG. 4. GAGING SHEETS BY LIMIT GAGES

The Tack-making Machines

One of these is shown in detail in Fig. 5, which is a very interesting example of automatic machinery of this class. The long strips are clamped in tongs on the end of a rod which slides through the tube *A* and is fitted inside so that it turns with it. The rod with its tongs and strip of material is fed forward by a cord and weight attached to the back end of the rod.

There are two punches *B* and *C*, both working in unison, but *B* is a little in advance of *A*, so that it cuts through the strip first. When this has been done the knife under *C* is forced down by it, completing the shearing from the end of the

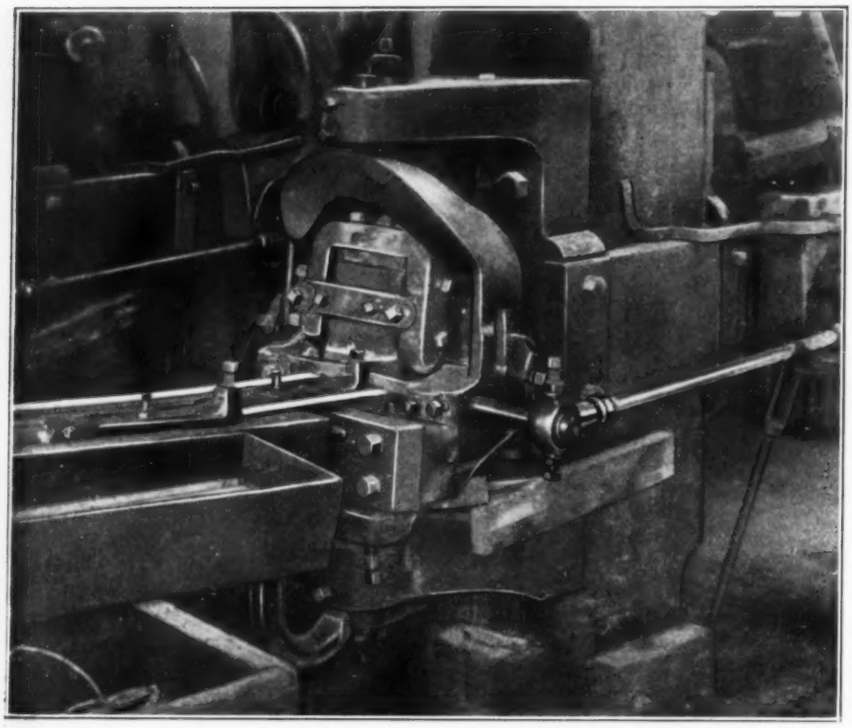

FIG. 6. HEEL NAIL MAKING MACHINE

strip, and at the same time carrying the blank down so that it can be gripped by jaws *D* and *E* which come in from each side and hold it to be headed. At the proper time the heading hammer *E* strikes a blow and the tack is completed, so that on the opening of the jaws it drops into the hopper beneath. Before the shearing knives *B* and *C* come down for the next tack the tube *A* together with the tongs and the strip of material have been rolled over one-half a revolution and the same operation is repeated.

This is done in order that the blank may be a sharp wedge, as shown in Fig. 7, which gives something of an idea of the evolution of the tack from the strip to the finished article. All the pointing is secured by cutting it off at a sharp angle and to do this it is necessary to revolve the stock half way each time, as

FIG. 7. FORMING THE TACK

this always brings the point at the left and leaves the material for heading in the right position.

Although this is apparently a very rough operation it requires considerable care in the making and setting of the dies in order to secure good tacks, as, although it may not have occurred to most of us, the shape of the head depends very largely upon the shape of the jaws holding the blank during the heading operation as well as on the stock itself. As the stock is always rectangular it may be said to depend on the dies, and if these are round the fairly round head results, while if they are allowed to become oblong or irregular the heads which are upset tend to assume the same shape and are not pleasing to the eye of an experienced tack maker.

THREE HUNDRED TACKS A MINUTE

Although these machines seem somewhat crude in many respects they are in reality a very nice piece of mechanism for this particular work and require very careful adjustment, as can be seen when they run at a rate of 300 complete tacks a minute. The heads are formed by simple upsetting for the ordinary carpet tack, but when it comes to the round head or gimp tack the forming die or button is used to insure the desired shape.

After the tacks have been made they are tumbled in tumbling barrels in which there is a little graphite and this, in addition to taking off the sharp edges, gives them a smoothness which is very agreeable to those who use them.

They are then put through the sorting screen shown in Fig. 8, being dumped in the hoppers at the back end and feeding to the inside of the perforated cylinders or screens. Those with defective heads will fall through these slots while the perfect ones go completely through the screen and into receptacles at the other end. In some cases, particularly the shoe nails which are used in connection with some of the shoe-sewing machinery for temporarily holding the soles and uppers together, great care is taken to have the heads perfectly smooth on the edge so as not to cut the leather should they come in violent contact with it. These nails are sorted several times, going through three banks of these revolving screens so as to be sure and sort out all defective heads. In addition to this they are inspected by hand, a large number being spread out over a sheet of zinc or other metal and the girl very soon picks out all

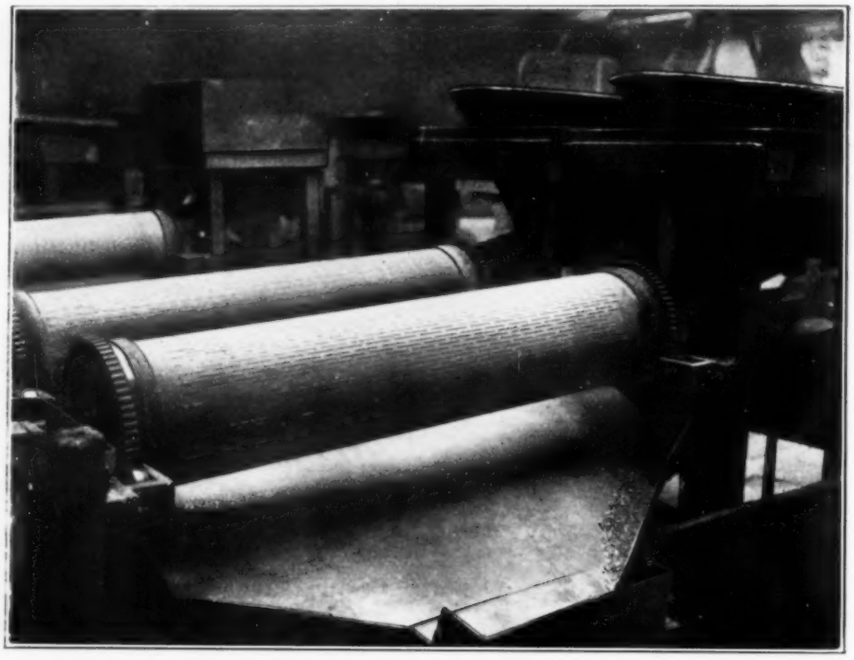

FIG. 8. SORTING FOR POOR HEADS

which have edges sharp enough to do damage.

A few figures in regard to the sizes of tacks may be of interest. All machine shoe tacks are cut from metal 0.032 to 0.035 inch thick, while the hand shoe tacks are made from sheets 0.032 to 0.072 inch in thickness. The heads on the machine shoe tacks are 0.109 inch, but on the hand shoe tacks they run from 0.109 to 0.150 inch.

Common or hardware tacks are made as follows:

Size No.	Length, Inch.	Thickness of Stock.	Size No.	Length, Inch.	Thickness of Stock.
2 oz.	1/4	0.032	12 oz.	1 1/8	0.065
2½ oz.	5/16	0.035	14 oz.	1 1/4	0.065
3 oz.	3/8	0.042	16 oz.	1 3/8	0.072
4 oz.	7/16	0.042	18 oz.	1 1/2	0.072
6 oz.	1/2	0.049	20 oz.	1 5/8	0.083
8 oz.	9/16	0.049	22 oz.	1	0.083
10 oz.	3/4	0.058	24 oz.	1 1/16	0.083

Making 2000 Heel Nails a Minute

In the making of the ordinary heel nail which is simply a steel wedge without any head being formed on the end, an entirely different class of machine is employed, as can be seen in Fig. 6. The strips in this case are clamped in the holders shown, which slide down ways in front of the nail-cutting machine, being fed as in the other case by rope and weight. In reality this is simply a shear which is run at the rate of 500 cuts per minute, and as there are four strips being fed down at the same time it makes 2000 nails per minute.

Instead of turning the stock over in this case as with the other tack machine, the whole machine oscillates back and forth around the trunnions, which can be seen top and bottom. This gives an angular cut, first one way and then the other, the whole machine being swung back and forth by the eccentric rod shown at the right. The stock stops against a plate directly behind the shearing knife, making a very simple arrangement and one which requires very little attention. It is rather interesting also to consider the reversal of the entire weight of this machine at the rate of 500 per minute, for, although it is not a very large machine it necessarily has considerable weight.

We are indebted to the C. W. Cross Company, Brockton, Mass., and particularly to Walter Taylor, its superintendent, for the information and illustrations secured in this connection.

The United States contains about 170 active foundries devoted to the manufacture of steel castings, not including other steel plants where castings are occasionally produced, incidental to their regular business. Of these 170, about 101 can make open-hearth castings, 43 can make bessemer-converter castings, and 45 can make crucible-steel castings.

A Discussion of Involute-spur and Helical Gearing

By Frank Burgess

In recognizing the fact that there is no cure-all for gear evils, it is evident that the exact involute tooth curve for specific duty is a subject that could be discussed without limit. Undoubtedly a large fund of information can be obtained by frequent discussions of this subject, which will be invaluable to the average mechanical engineer; yet I am positive that there is no theory that can be applied to all classes of gearing and not even to the various kinds in the limited spur-gear field. The subject of tooth curves is one covering a multitudinous number of applications. Each problem must be solved on its own merits. For ordinary purposes, however, the general standard which has been in use for about a quarter of a century is suitable for most commercial purposes. Yet there are many problems that have arisen during the last five to ten years where this general standard is not suitable as a solution. Machines are now built for high-speed, high-duty; a maximum of efficiency, durability and economy, and a minimum of vibration and noise. The designing and proportioning of the parts entering into such machines are a severe tax upon the mechanical engineers of today, particularly those problems that are in the realm of kinematics. Such problems are only imperfectly understood in spite of the large amount of superior machinery that has been designed and built during the last 15 years. It is surprising what stupendous ignorance is manifested by some manufacturing concerns who are investing thousands and thousands of dollars in machinery, and are not getting the satisfactory results that are to be expected from such enormous expenditures.

With reference to high-speed and high-duty machines, much thought and attention has been given to the subject of high-speed tools and high-speed steels. In many such cases the manufacturers have adopted lines of gearing suitable for the purpose intended and wonderful results have been obtained. For instance consider the growth and development of the automobile industry during the last 10 years, and consider the large part played by gearing in the automobile mechanism.

Tooth curves for involute-spur gearing have nearly reached a development that can be characterized as perfect. For gears having less than 30 teeth the problem has been a severe one. The difficulties have been to get real efficiency and durability, combined with a lack of vibration and noise. My own solution of problems involving a small number of teeth, less than 30, is the use of helical teeth designed for the specific conditions involved, instead of the use of spur teeth. I am willing to make the broad statement that no gears designed to run at a high speed should be designed or cut with anything but helical teeth, provided the smallest gear of the pair contains 20 teeth or less, and in most instances 30 teeth or less.

The usual stock cutters in the market for spur gearing are seldom made to be used for cutting gears with less than 12 teeth; even for special purposes pinions are rarely cut with less than 8 teeth, and in such cases the pinion is usually the driver. It is practically impossible to transmit power with a pinion having less than 12 teeth as the driven member. If, therefore, a driven spur gear is impractical with less than 12 teeth, it is quite obvious that as the number of teeth decreases the difficulty of obtaining satisfactory results, that is a minimum of vibration and a maximum of durability and efficiency are likewise increased. If this argument applies to a gear or pinion with a small number of teeth, the indications are that the same principles will apply to gears with a larger number of teeth, though not, however, in the same ratio.

Today very few engineers are disputing the fact that the helical tooth is the best form of tooth for refined gear movements. The principal reason why this form has not been adopted and universally used has been one of expense in manufacture. An additional reason is that such gears have not been thoroughly tested by the average gear user, and thus there is a lack of knowledge as to their efficiencies. Again the average designer does not know that helical gears are a standard commercial article and as such are adapted for the average purposes for which spur gears are used.

Referring again to the subject of tooth curves, and particularly to the question of the depth of tooth, I am satisfied that for the ordinary gear of today the so-called standard depth is a depth that should be universally used. However, I am greatly in favor of the 20-degree pressure angle, and on the whole my preference is for involute teeth having a pressure angle of 20 degrees and a depth the same as is now considered standard for the 14½-degree pressure angle. I believe that no gear whatever with 15 teeth or less should be cut with an angle less than 20 degrees; only for a very few special purposes would I advise a greater pressure angle to be used.

When gears are made to run together with a contact of three or four teeth, vibration is generally eliminated, if the gears are accurately cut. When, however, the contact is only two teeth, or less, vibration is nearly always present. The problem, therefore, of proper design resolves itself for general purposes, such as slow-speed gears for heavy transmissions, into first, the tooth curve, and second, the materials. The materials for two gears in mesh should be carefully selected with reference to the work that is

to be done. In general the smaller gear should have the stronger material. This fact has been very forcibly demonstrated to me. It is remarkable with what rapidity certain gears will lose their efficiency and become useless because of excessive vibration, and also what a slight change in the design of a similar gear will produce remarkable efficiency and durability.

Whereas there has not been any novel invention in this line within the last few years, there has been a steady developing and perfecting of old ideas. The improvements in gear-cutting machinery have been one of the most potent attributing causes to this development. To summarize briefly; I believe that the ordinary requirements in gear movements have been already attained; yet there are many problems not fully solved, particularly in the field of severe requirements. These problems are still in the process of evolution, and 10 years hence what now seems impossible will no doubt be possible.

Annealing Iron Castings

By T. Toot

It happens quite often that one comes across extremely hard iron castings that refuse to be drilled or machined. Some castings that broke, by simply center punching them, we made as soft as common wrought iron and they drilled as easily. The castings referred to were very thin and considerably warped. They were required to clamp a door tightly but they invariably broke when pulling up the bolts.

Having a wrought-iron heating furnace in our shop, we converted it, for the time being, into a malleable plant, only using different absorbing or annealing material. To do this we got a supply of old sheet iron boxes from the junk pile, a supply of burned molding sand, that was perfectly dry, from the foundry and a few sacks of fat pine chips from the planing mill. I then proceeded to put a layer of molding sand in the bottom of each box and on this about 1 inch of pine chips and the castings on top of that, being careful that they should not touch each other or the sides of the box. More pine chips were then packed closely on the top and side to a depth of about 1½ inches and the box then filled with the molding sand. After this the box was placed in the furnace and subjected to a low heat for fourteen hours; it was then withdrawn and allowed to cool.

After this treatment, the castings were perfectly soft and we had no trouble whatever with them, as they drilled easily and could be pulled up on the door as tightly as possible without breaking.

Some years after, I received another job of a much heavier character; it being castings that weighed perhaps 20 pounds each, while those in the first instance weighed but a few ounces. On these I used a heating furnace also, but packed the castings differently.

After letting the furnace go down on Saturday afternoon, I made a good bed of molding sand, and then pine chips, then laid the castings on them about two inches apart. I then put about six inches of chips on top and covered the whole with perhaps ten inches of the burnt sand. I then fired the furnace and kept it at a low red heat until the following Monday morning, when I had them uncovered and let them and the furnace cool down.

When withdrawn, the castings were found extremely soft and in splendid condition. As these pieces were to take the place of malleable castings, I had my doubts about their being soft enough, but when tested it was found they were really better than the castings we were buying. As we were getting a very rocky article just at that time, however, it is not saying a great deal.

The burnt sand alone is an excellent article to anneal hard castings, and I claim no laurels for its discovery, having read of its merits years ago in a scientific journal, but being a steel worker, and doing a great deal of my heating with pine wood, I had noticed what a softening influence it had on Mushet steel, therefore when the opportunity offered to try its effects on gray-iron castings, I was glad to try it.

An Automatic Machine for Cutting Worm Sectors

By Joseph G. Horner

French machine-tool makers have developed a number of highly specialized machines which are used in the automobile industry, some of them betraying considerable ingenuity in design. In the accompanying drawings I show a machine of this class, constructed solely for cutting the worm sectors which are used in the steering gears of automobiles. The blanks are of forged steel, bored to take the shaft,

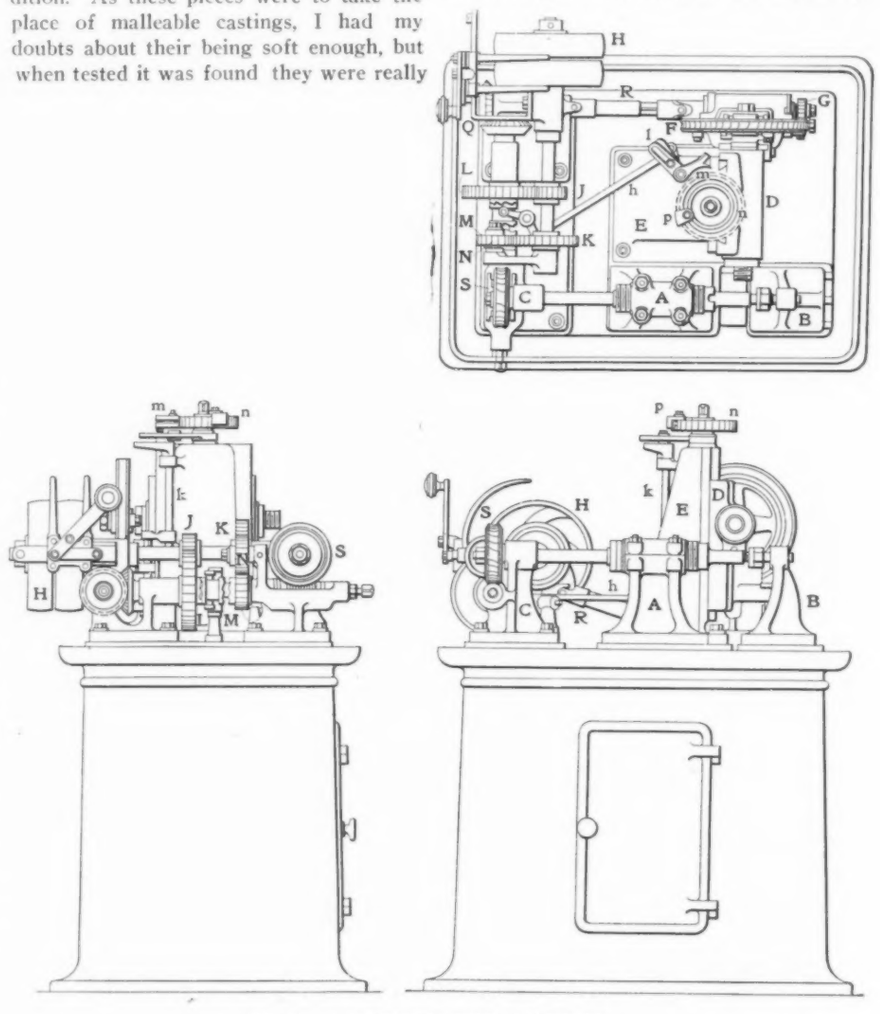

FIG. 1. A SECTOR-CUTTING MACHINE

and with a lever formed in one with the forging. The machine then holds the blank by its bore, on a mandral, and a hob cutter produces the teeth in a series of traverses, the cut gradually deepening until the final depth is reached. The operation is entirely automatic after setting the piece.

Fig. 1 gives three general views of the machine, and subsequent views are details of the mechanism. In Fig. 1 it is seen that a box base forms the support for the mechanism and that the cutter spindle is fitted in a main bearing *A* with an adjustable outboard stay *B* for the end of the arbor, which is provided with a nut.

A bearing *C* also supports the spindle. The work spindle runs in a bearing *D* capable of being slid up and down the bracket *E*. On the end of the work spindle is a worm wheel *F* rotated by a worm in a box below it, and the relative rates of rotation of the work and the cutter spindles are arranged to suit the sector being cut. Change gears at *G* form the means of effecting the different ratios.

The driving of the two spindles is derived from the fast and loose pulleys at *H* turning a shaft on which are two spur gears *J* and *K*, the first engaging with a wheel *L*, the other with a wheel *M* through an intermediate *N*, which reverses the direction of motion, and greatly increases the speed also. Either of these sets can be made to drive a shaft *O* (see Fig. 2) by throwing a claw clutch *P* to right or left. The turning of *O* imparts motion to a pair of miter gears *Q* and these rotate a shaft to which is connected a telescopic universal-jointed shaft *R*, driving the first of the change gears at *G*. Provision is made, by mounting the first and second gears on shafts in eccentric bushings, to put differently sized wheels, or to insert an intermediate, so that the direction of rotation is changed, and left-handed sectors can be cut. The cutter spindle is driven from *O* through the worm gear at *S*.

Looking at Fig. 3 it will be observed that the dividing worm wheel *F* has a circular tee-slot on its back, with two stop-blocks *a* and *b*, bolted on. As the wheel turns, one block strikes a lever *c*, keyed on the end of a shaft which carries a pinion *d* and causes *d*, by virtue of its engagement with a rack *e* on the back of the elevating nut, to lift the work-spindle slide *D* bodily, so that the sector is hoisted right out of engagement with the cutter.

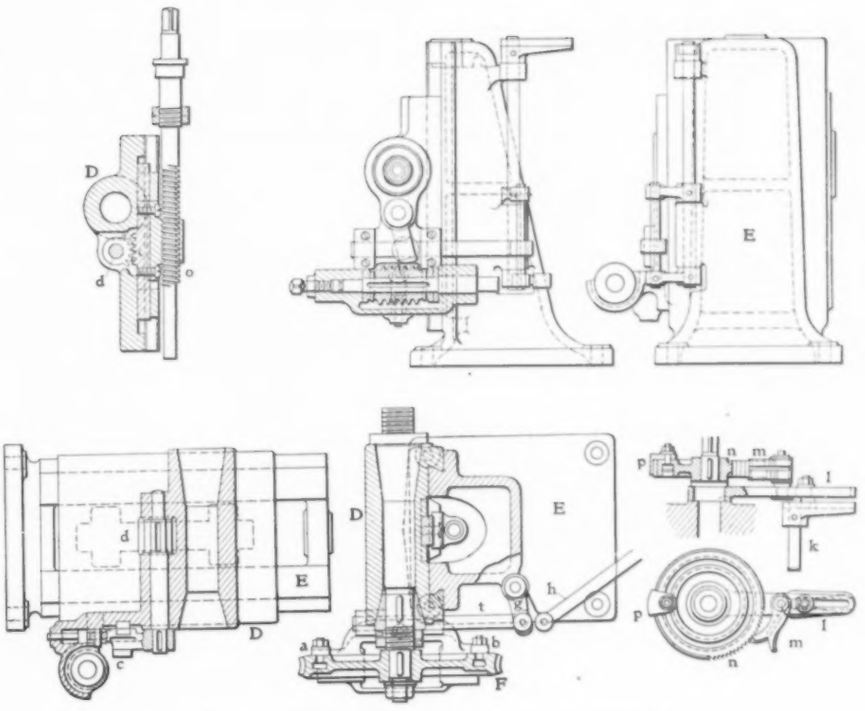

FIG. 3. DETAILS OF WORK-CARRYING MECHANISM

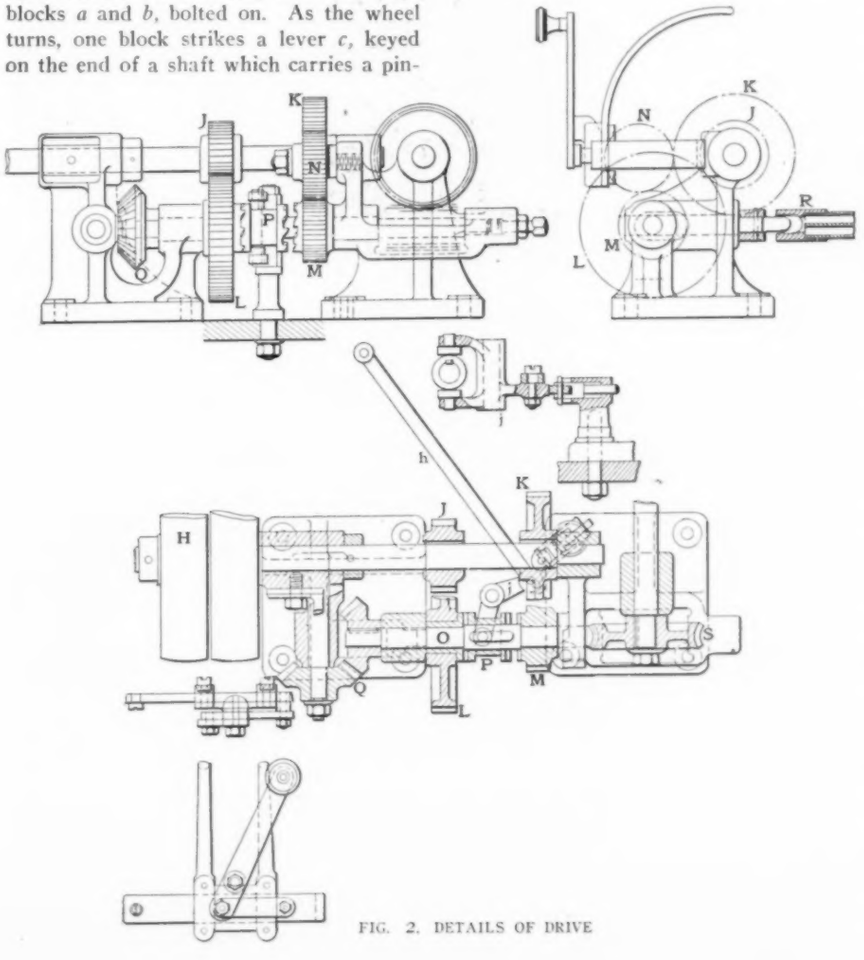

FIG. 2. DETAILS OF DRIVE

Simultaneously the lever *c* moves a connecting rod *f*, on a vertical shaft, and so operates a short lever *g*, coupled to a long one *h*, which operates a forked lever *j* moving the clutch *P*. This has the effect of reversing the motion, and of running the sector back at high speed. Simultaneously a movement is given, by the twisting of the vertical shaft *k*, actuated from *f* to the slotted link *l*, which works the pawls *m*, and feeds the ratchet wheel *n* around a part of a revolution, thus putting on a certain amount of feed to the screw *o*, which feeds the slide *D* down. The other stop-block on the back of *F* now comes into operation, and has the effect of moving *c* in reverse fashion, so that the pinion *d* lowers the slide to its former position, plus the amount of feed given by the ratchet. The lever *h* is also moved and the clutch *P* thrown over, so that the slow cutting again commences. This is repeated until the proper depth of cut is reached, when the block *P*, set in a groove in *n*, strikes the pawls *m*, and throws them off the teeth. An electric indicator then announces to the attendant that the work is finished.

The working of the machine is simple, and the attendant is able to devote much of his time to other work while cutting is going on. The setting up is also simple, since the gears are calculated so it is only necessary to place one change wheel with the same number of teeth as the sector being cut, and the other with teeth equal to nine times the number of threads in the cutting hob. The weight of this machine is about 1600 pounds.

It is made by Messrs. Brenot, Buronfosse & Cie., of Paris, and was shown at the late Franco-British exhibition.

A Ball-Bearing Testing Machine and Its Work

Results Give Characteristic Friction Curves for Various Types of Bearings and Show Detrimental Effects of Thrust Load on Radial Bearings

EDITORIAL CORRESPONDENCE

About a year ago a carefully worked out ball-bearing testing machine was installed at the plant of the Hess-Bright Manufacturing Company, Philadelphia. Mr. Hess prepared the design and specifications for the machine, and the work of building was carried out by the Riehle Brothers Testing Machine Company, also of Philadelphia. It is probably the most effective machine for the purpose intended in existence today, and by its use a large fund of valuable data has been accumulated. We are fortunate in being able to present illustrations of this machine, together with tabulated data and plotted curves showing the characteristics of cercertain types of ball bearing.

Purposes for which the Machine Was Devised

The machine was developed to test ball bearings by running them under various conditions of loads and speeds. Two types of load are provided for: the one, radial or normal to the shaft of the bearings, the other axial or parallel to the shaft. Furthermore, there are arrangements so that both kinds of load can be applied to a bearing simultaneously.

The measure of success or failure of any ball bearing comprises two elements: the carrying capacity and the frictional resistance. The machine was, therefore, designed to be capable of applying radial loads up to a maximum of 15,000 pounds, and thrust loads up to a maximum of 10,500 pounds under rotative speeds ranging from 50 to 1500 revolutions per minute. Within these limits of loads and speeds the coefficient of friction can be accurately determined when radial load only is applied, when thrust load only is applied, and when both radial and thrust loads are applied simultaneously.

Design of the Ball-bearing Testing Machine

Turning to the illustrations, Figs. 1 and 2 show two views of the testing machine. Fig. 1 shows the arrangement for testing under radial load only; Fig. 2 shows the arrangement for testing under thrust load only. The necessary arrangement when both thrust and radial loads are used will be cared for in the following description:

The machine is seen to consist of a substantially designed pillar carrying a system of weighing levers at the top, with another similar system on a detached bracket at the rear. Both bracket and pillar are supported from a common base plate. Near the bottom of the pillar is a shaft carried in large ball bearings and driven by a pulley indicated by the letter *A* of Fig. 2. On the nose of a spindle in this shaft is placed the bearing to be tested. Such a bearing in position is indicated by the letter *B* of Fig. 1. Surrounding this bearing and accurately fitted to its external diameter is a steel disk which in turn is accurately fitted in the yoke *C*.

FIG. 1. BALL-BEARING TESTING MACHINE ARRANGED FOR RADIAL LOADS

This yoke is connected to the vertical rod D through a shackle provided with knife edges. This rod in turn is connected to the main weighing levers through knife-edged joints, and, in fact, the entire weighing lever system is provided with knife edges throughout. The load is applied to this weighing-lever system at the point E. When a bearing is in position, as has been described in connection with Fig. 1, and is loaded with a radial load and rotated by means of the shaft, such rotations will cause a swinging of the yoke about the center of the bearing shaft, thus causing a horizontal deflection of the joint between the yoke and the vertical rod. This deflection bears a certain relationship to the force of friction and thus to the coefficient of friction.

This relationship is expressed by the equation:

$$\mu = \frac{6\,d}{5\,r},$$

in which μ equals the coefficient of friction, d the horizontal deflection of the joint and r the radius of the bearing bore, or the normal shaft diameter for which the bearing is made. Thus the factors to be noted in conducting a test of a ball bearing under radial load are: The load on the bearing and the horizontal deflection of the joint between the yoke and the rod. In practice it has been found wise to reverse the direction of rotation of the bearing for each set of load conditions and thus obtain two deflection readings which are averaged.

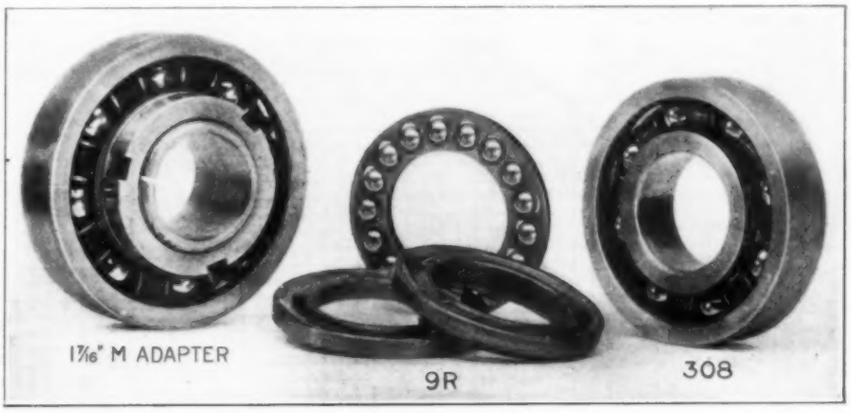

FIG. 3. TYPICAL FORM OF BEARINGS

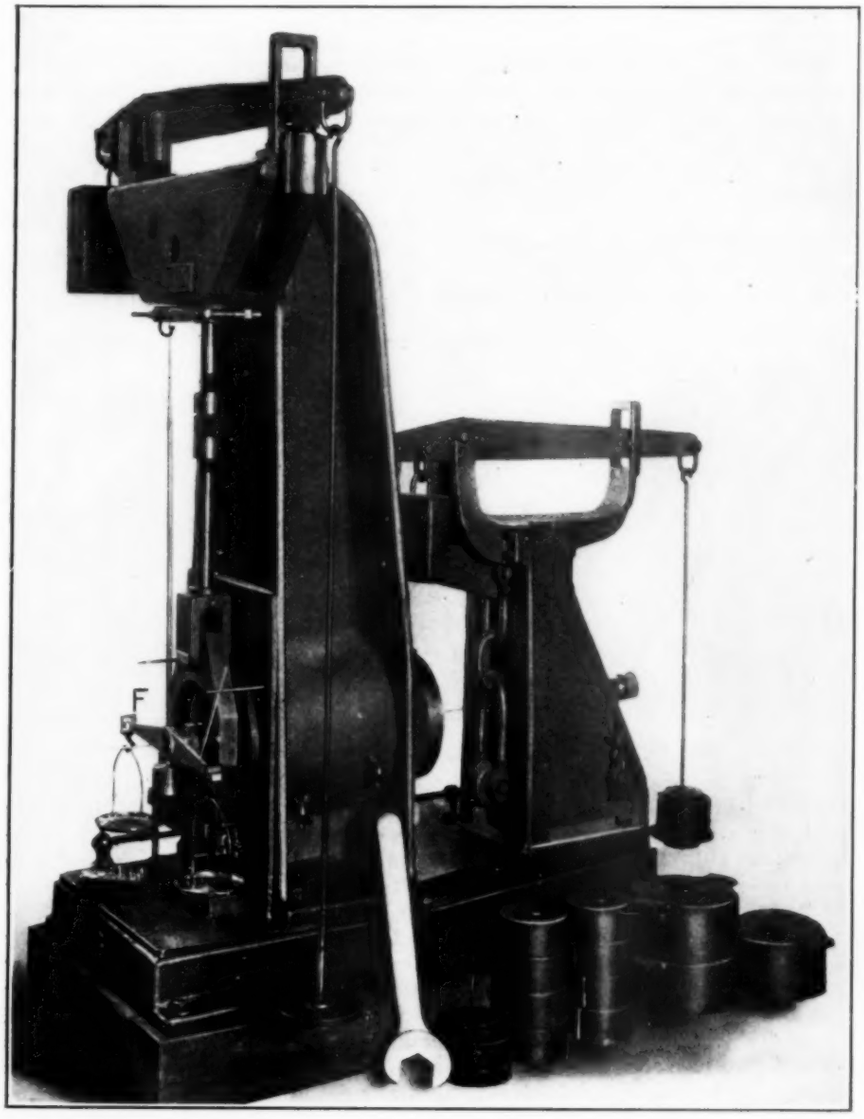

FIG. 2. BALL-BEARING TESTING MACHINE ARRANGED FOR THRUST LOADS

The deflection is measured in the following manner: A short distance below the knife-edge joint and attached to the end of the rod is a silver plate carrying a very fine vertical line. In front of this plate and properly supported from the pillar of the machine is a microscope with focal and transverse adjustments. The horizontal motions are under control of a micrometer disk so graduated that 0.0001 inch can be read on its vernier scale and finer readings obtained by interpolation. The cross hairs of the microscope are brought into register with the line on the silver plate with the bearing at rest. Then with the machine running the microscope is moved horizontally until the cross hairs and line again register. As we noted above two readings are taken, one for each direction of rotation and these two readings averaged in order to obtain the factor for determining the coefficient of friction. Illumination of the silver plate is obtained by means of an incandescent lamp. Referring to Fig. 1 the microscope with its method of mounting and the light for illumination are plainly shown. By referring to Fig. 2 the silver plate on the rod end can be seen.

Testing a Thrust Bearing

A thrust bearing to be tested is mounted by means of a suitable holder on the nose of the spindle in a manner similar to the mounting of a radial bearing. To the outer edge of the bearing is attached the yoke F by a forcing fit. To this yoke is clamped by taper jaws a long piece of No. 32 music wire, which passes through the main shaft and to the weighing device at the rear. This weighing system is plainly shown in Fig. 2; load thus applied is a direct pull upon the outer bearing race and is resisted by a large thrust bearing adapted to the shaft of the machine.

To this yoke F is attached a long pointer which swings across a scale situated at the upper part of the machine. See the letter G of Fig. 2. The ends of this yoke terminate in knife-edge bearings upon which are hung scale pans. When a bearing is under test, the force of friction tends to deflect or swing this yoke and the pointer attached to it. This swinging force is balanced by means of weights placed in the scale pans; as in the test of

mined entirely from the observations of the deflection of the joint between the yoke and rod.

The sensitiveness of the machine is such that the one hundred thousandth part of an inch can be estimated in reading the microscope in connection with radial loads; the scale used for testing axial loads will respond appreciably to weights of 0.0005 pound placed in the scale pans; with combined loading the error produced

To show characteristic readings as observed in using the machine, and the coefficients of friction as determined for a No. 308 radial bearing and a No. 9R thrust bearing, Tables 1 to 4, inclusive, are presented. Table 1 is the log of a test of a No. 308 radial bearing at a speed of 325 revolutions per minute under loads varying from 400 pounds to 2800 pounds, by increments as shown. The actual vernier readings are given, the difference is

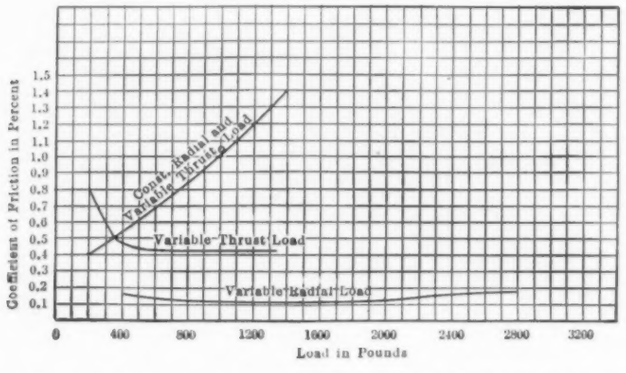

FIG. 4. CHARACTERISTIC CURVES FOR A NO. 308 RADIAL BEARING

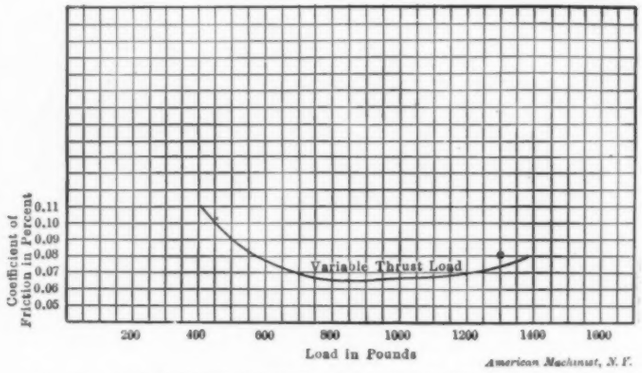

FIG. 5. CHARACTERISTIC CURVE FOR A NO. 9 THRUST BEARING

radial bearing two observations are made, one with the bearing running in each direction. These weights are then averaged and this average weight times the lever arm of the yoke equals the torque produced by the frictional resistance of the bearing. The coefficient of friction is expressed by the equation

$$\mu = \frac{T}{L \times R},$$

in which μ equals the coefficient of friction, T the torque, L the load and R the radius

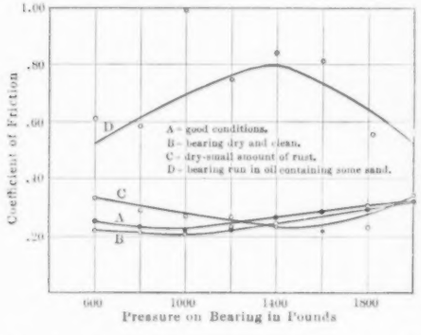

FIG. 6. FRICTION CHARACTERISTICS OF A RADIAL LOAD BALL BEARING NO. 308 UNDER NORMAL CONDITIONS AND UNDER ABUSE

of the bore of the bearing, or the diameter of the shaft to which the bearing is to be applied.

Test of a Radial Bearing with both Radial and Axial Loads

When a radial bearing is to be tested with both radial and axial loads, the loads are applied in the same manner and by the same mechanism as has been described for each load separately. The coefficient of friction, however, is deter-

by the torsion of the wire, No. 32 music-wire gage, used to apply thrust loads is equal to one-half of one per cent. for a load of 245 pounds. As the thrust loads are increased, this error is proportionately decreased.

Typical Bearings and their Characteristic Curves

Fig. 3 shows three typical bearings made

shown together with the average, and the corresponding coefficient of friction in per cent. The last column of the table gives a few observations of the oil temperature.

All of the bearings under test are run with a surplus of oil as shown from their position with reference to a small oil tank in Figs. 1 and 2. It is possible to run special tests with bearings dry or with bearings fed with sand or under other ab-

FIG. 7. PARTS OF BALL BEARINGS TESTED TO DESTRUCTION

by the Hess-Bright Company. From right to left they are, one No. 308 radial bearing having a bore diameter of 1.5748 inches containing 8 balls with separators and having a rated radial load at constant speed of 1450 pounds. The middle is a No. 9 R thrust bearing having a bore of 1.7716 inches, contain 17 balls and having rated thrust loads of 4600, 1550, 1200, 900, 775 and 650 for speeds of 10, 150, 300, 500, 1000 and 1500 revolutions per minute, respectively. The bearing at the left is a 1 7/16-inch M adapter bearing, used mainly in line-shafting work.

normal conditions, but to determine the action of a bearing under what can be classed as normal running conditions, such tests are carried out with an ample supply of a good quality of machinery oil.

Returning to Table 1, a noteworthy feature of the column headed "Coefficient of Friction in Per Cent." is the slight variation of the various qualities tabulated, although the loads range from 400 pounds up to 2800 pounds; this latter load is nearly double the rated load for the bearing. This nearly constant coefficient of friction at a given speed and with varying

Radial Load.	Vernier.	Vernier.	Difference.	Average.	Coefficient of Friction in Per Cent.	Oil Temperature, Degrees Fahrenheit.
400	44875	44661	0.00214	0.00107	0.1633	
600	44851	44652	0.00199	0.000995	0.1517	
800	44663	44489	0.00174	0.000870	0.1325	79.1
1000	44581	44390	0.00171	0.000855	0.1302	
1200	44602	44439	0.00163	0.000815	0.1240	
1400	44524	44366	0.00158	0.00079	0.1200	
1600	44506	44349	0.00157	0.000785	0.1195	82.5
1800	44443	44276	0.00167	0.000835	0.1272	
2000	44467	44281	0.00186	0.00093	0.1416	84.0
2400	44452	44231	0.00221	0.001105	0.1686	
2800	44469	44229	0.00240	0.00120	0.1830	85.5

Room temperature, 76 degrees Fahrenheit.
Speed, 325 revolutions per minute.
Bearing, No. 308. Bore, 1.5748 inches.
Rated radial load, 1450 pounds.

TABLE 1. LOG OF TEST ON A NO. 308 RADIAL BEARING UNDER A VARIABLE RADIAL LOAD.

Thrust Load.	Vernier.	Vernier.	Difference.	Average.	Coefficient of Friction in Per Cent.	Oil Temperature, Degrees Fahrenheit.
200	43846	43318	0.00528	0.00264	0.402	72.10
400	43932	43222	0.00710	0.00355	0.541	
600	44011	43109	0.00902	0.00451	0.687	75.7
800	44117	43018	0.01099	0.005495	0.837	
1000	44259	42881	0.01378	0.00689	1.050	79.30
1200	44326	42763	0.01563	0.007815	1.191	
1400	44443	42596	0.01847	0.009235	1.406	84.5

Room temperature, 73 degrees Fahrenheit.
Speed, 325 revolutions per minute.
Bearing, No. 308.
Constant radial load, 400 pounds.

TABLE 2. LOG OF TEST OF A NO. 308 RADIAL BEARING UNDER A CONSTANT RADIAL AND VARIABLE THRUST LOAD.

loads is one of the characteristic features of the type of radial bearing indicated as No. 308 in Fig. 3.

Table 2 shows this same bearing run at the same speed, 325 revolutions per minute, carrying a constant radial load of 400 pounds and a variable thrust load ranging from 200 pounds to 1400 pounds with increments as indicated in the first column. The vernier readings, differences, average, coefficient of friction and oil temperature are given in a manner parallel to Table 1. Consideration of the coefficients of friction in per cent. shows that the friction steadily increases as the load is applied, though not in the same proportion. This increase is again a characteristic of this type of bearing when subjected to a constant radial load and an increasing thrust load.

Table 3 is the log of a test on this same type and size of bearing under a variable thrust load only ranging from 200 to 1350 pounds by increments as indicated. Glancing at the column showing the coefficient of friction in per cent., it is seen that the values decrease as the load increases, or at least show that tendency; this is quite marked in the beginning of the series and less so toward the end. This decrease in the coefficient of friction as the thrust load is applied to this type of radial bearing is another of its characteristics.

Table 4 shows the log of a test on a No. 9R thrust bearing. The loads range from 400 to 1400 pounds, increasing throughout the test by increments of 100 pounds. The balancing weights are indicated, the average shown, the torque given, the coefficient of friction in per cent. and for certain of the tests, the oil temperature. Considering the coefficient of friction, it will be noticed that it is much lower in actual value than for the radial bearing No. 308. It will also be noticed that there is a tendency for the value to decrease as the load is applied. This decrease is uniformly true for the first seven readings, after which there is a tendency to slightly increase. This characteristic of a decrease in the coefficient of friction for this type of thrust bearing as the load increases is one of the bearing characteristics.

In order to show these characteristics more plainly, the curves in Figs. 4 and 5 have been plotted from the tabular values of Tables 1 to 4, inclusive. Fig. 4 shows the results from Tables 1, 2 and 3, and applies to the radial bearing No. 308. Similarly the curve of Fig. 5 is plotted from Table 4 and applies to thrust bearing No. 9R. Detailed comment is unnecessary, as the curves are characteristic for the conditions as noted.

One important point should be noted, the bearing of the type of No. 308, and known as a radial bearing, is designed principally to carry only radial loads. Thrust loads also may be imposed on it, but in smaller amount. The makers limit the thrust load to one-fourth of the radial, i.e., with a radial bearing of 1450 pounds rated radial capacity, the total thrust carrying capacity would be 360 pounds.

At the June, 1908, meeting of the American Society of Mechanical Engineers, Mr. Hess presented a brief descrip-

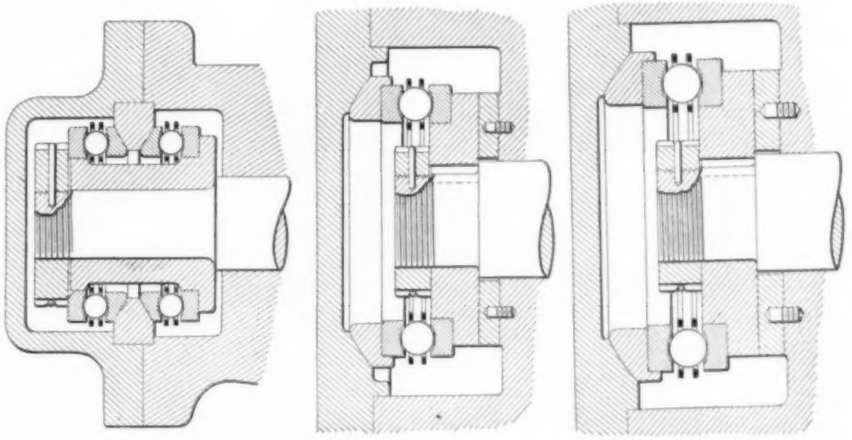

FIG. 8. SUGGESTED ARRANGEMENT OF THRUST BALL BEARINGS FOR PUMPS

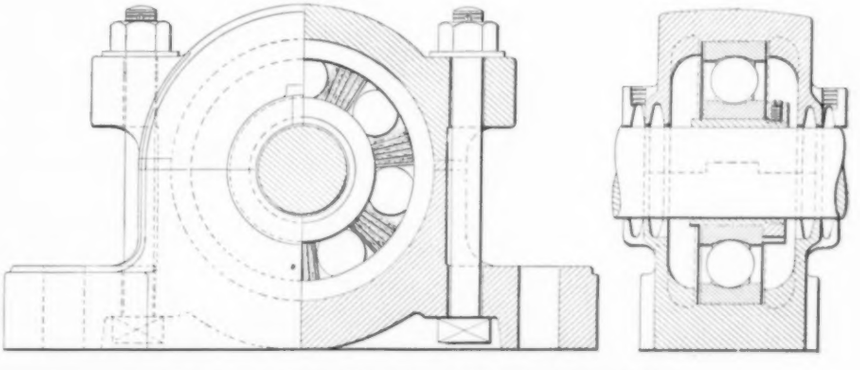

FIG. 9. ARRANGEMENT OF A BALL-BEARING PILLOW BLOCK

tion of this testing machine and curves plotted from data derived from its use. From this paper, we reproduce Fig. 6 in order to show the effect of certain abnormal conditions on ball bearings. The bearing thus tested was No. 308 and the results are, therefore, of value as being directly comparable with the results plotted in Fig. 4. From the paper to which we have referred, we quote:

"The behavior of radial bearing No. 308 under radial loads only, as measured by the coefficient of friction is plotted in Fig. 6. This was tested, first immersed in oil, then thoroughly washed clear of oil in gasolene and dried, then slightly rusted. The rated load for steady load and uniform speed is 1400 pounds. The perfection and finish of the races and balls and truth of the parts is shown by the very small difference between the oiled and dry bearing. At about 25 per cent. overload, the influence of deformations in their effect on the true rolling becomes manifest in a crossing of the oil and dry curves, with the latter becoming higher. As was to be expected, the slightly rusted bearing showed the higher friction, but the unexpected result is shown of this friction becoming less than that of the unrusted bearing at about 1400 pounds; but between 1800 and 2000 pounds, the friction rises sharply indicating a probable early destruction of the bearing under prolonged running. Because dry and oiled curves show a similarly low friction, it is not safe to deduce the permissibility of running without oil. Prolonged dry running will surely prove destructive."

Several bearings have been tested to destruction with this valuable machine and Fig. 7 is presented as showing the way in which the inner race, or cone, cuts and tears at the time of destruction. This is the part of a bearing that usually fails first as the relative curvature between it and the balls is less advantageous than between the balls and the outer race. In the center of the half-tone are two pieces of an outer race from a bearing that was tested to destruction.

Finally, it is perhaps not out of place to show a few applications or mountings of ball bearings. To that end Figs. 8 and 9 are presented. In Fig. 8 are three mountings of a thrust bearing for pumps; Fig. 9 shows a pillow-block mounting for heavy service. In both cases, the details are so plain as not to require a description.

Thrust Load.	Balance Weight.	Balance Weight.	Average.	Torque.	Coefficient of Friction in Per Cent.	Oil Temperature, Degrees Fahrenheit.
200	0.132	0.125	0.128	1.262	0.803	73
400	0.158	0.148	0.153	1.509	0.479	
600	0.218	0.201	0.209	2.061	0.436	76
800	0.288	0.267	0.277	2.732	0.434	
1000	0.355	0.343	0.349	3.440	0.437	80
1200	0.412	0.413	0.412	4.061	0.431	
1350	0.446	0.485	0.466	4.600	0.433	85

Room temperature, 74 degrees Fahrenheit.
Speed, 325 revolutions per minute.
Bearing, No. 308.

TABLE 3. LOG OF TEST OF A NO. 308 RADIAL BEARING UNDER A VARIABLE THRUST LOAD.

Thrust Load.	Balance Weight.	Balance Weight.	Average.	Torque.	Coefficient of Friction in Per Cent.	Oil Temperature, Degrees Fahrenheit.
400	0.0359	0.0410	0.03845	0.379	0.1070	
500	0.0380	0.0470	0.0425	0.419	0.0945	70.5
600	0.0406	0.0445	0.04255	0.420	0.0790	
700	0.0395	0.0485	0.04435	0.437	0.0705	71.5
800	0.0490	0.0592	0.04960	0.488	0.0690	
900	0.0545	0.0560	0.05525	0.545	0.0684	73.0
1000	0.0610	0.0600	0.06050	0.596	0.0673	
1100	0.0650	0.0734	0.06920	0.682	0.0700	73.5
1200	0.0735	0.0870	0.08025	0.791	0.0710	
1300	0.0795	0.1115	0.09550	0.942	0.0817	74.5
1400	0.0735	0.1255	0.09950	0.980	0.0791	

Room temperature, 70 degrees Fahrenheit.
Speed, 495 revolutions per minute.
Bearing, No. 9-R. Bore, 1.7716 inches.

TABLE 4. LOG OF TEST OF A NO. 9-R THRUST BEARING UNDER A VARIABLE THRUST LOAD.

Die Molded Castings

By A. Trowbridge*

Castings that are made by forcing molten metal, under pressure, into steel molds are becoming more prominent, and finding more uses every day, as they can be cast to the exact size, thus doing away with any machining. They can be used economically whenever a large number of pieces of one shape are needed that do not require a high tensile or compressive strength.

The more complicated the form of the piece, or the more difficult it would be to machine, the greater will be the saving by having it cast to its finished shape.

A good example of the character of work for which die-casting has been found extremely profitable is shown by Fig. 1. This is shown full size and the fact that the driving key is cast inside the hub shows how complete these castings are. It is obvious that to cut out the raised letters on the periphery of each wheel would be so expensive an operation as to almost prohibit their manufacture.

The remarkable degree of accuracy attained in making parts by die-casting is very well illustrated by Fig. 2. This shows the case and cap of a Veeder trip cyclometer, the two parts being cast separately, but so accurately that they fit together perfectly, the cap being recessed around the edge to receive the lip which extends around the edge of the case. Attention should also be called to the fact that the hub *A* in the case must line up perfectly with the hub *B* in the cap, and that the main hub *C* in the case must line up perfectly with the deeper portion of the cap.

To meet all these conditions it is apparent that not only must the dies be made correctly, but the metal must stay in the form in which it is cast. That is, there must be no warping, nor uneven shrinkage, nor should the metal change after it has cooled. The metal used by the Veeder Manufacturing Company is of such a composition that the castings hold their shape without any perceptible change, whatever shrinkage there is being uniform.

FIG. 1. CASTING FOR CASH REGISTER

The basis of "Veeder metal" is tin. This makes the castings lighter than brass pieces of the same size. It also makes a white metal which is uniform in color throughout and does not tarnish on exposure to the air or to moisture. This nontarnishing quality makes it possible to use these castings without plating them, and should they become worn from contact with the fingers, or with other parts, no change of color is noticed. The metal can be plated, if desired, and a surface obtained to match the color of any other metal. When it is necessary to machine the parts, a properly sharpened tool leaves a clean bright surface that needs no further polishing. Castings made from this tin alloy can also be spun or riveted, making it possible to fasten the parts together, or to parts made from a different metal, very economically and efficiently.

Die-molded castings are smaller than the sizes of the dies in which they are made because the metal shrinks somewhat

*Shop manager for Veeder Manufacturing Company.

in cooling. This shrinkage varies with the shape and size of the piece. It can be calculated closely for simple pieces, but when it is necessary to match parts made in any other way, it is advisable that the die castings be made first and the other parts fitted to them. If this is not done, the dies must, in some cases, be so made that they can be ground down to size after a number of sample castings have been made to determine just what the shrinkage will be.

The exact strength of the metals which can be cast in steel dies is of vital importance in determining their usefulness. The tensile strength of "Veeder" metal is about equal to that of cast iron, being 15,000 pounds per square inch. Its compressive strength is about 20,000 pounds per square inch, hence it is not adapted for use under heavy pressure.

This metal is much more ductile than cast iron and can, as a consequence, be used for very thin pieces. Moreover, its toughness permits of its being tapped even though the walls are very thin. It is apparent that to secure uniformity of castings, the treatment of the metal in this work must be uniform. On account of this no variation of hardness can be obtained except by varying the alloy. The amount of this variation is quite limited with any one metal so that proper allowances must be made in the design of die-molded parts to secure the necessary strength and rigidity. Aluminum has not been successfully cast in dies.

Some variation can be made in the composition of the metals used for die-casting and various degrees of hardness and

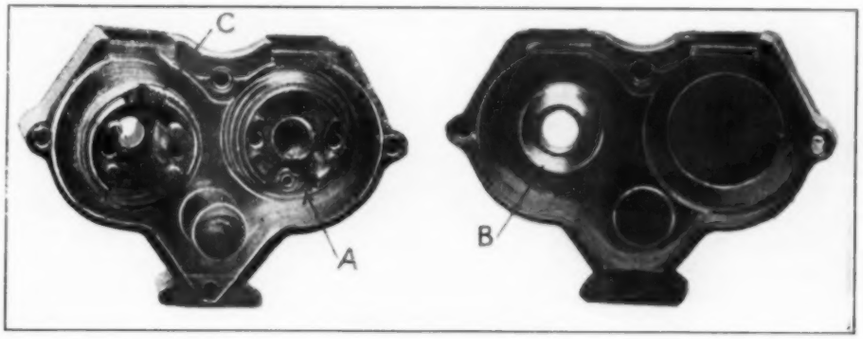

FIG. 2. DIE CASTING OF VEEDER TRIP CYCLOMETER CASE AND CAP

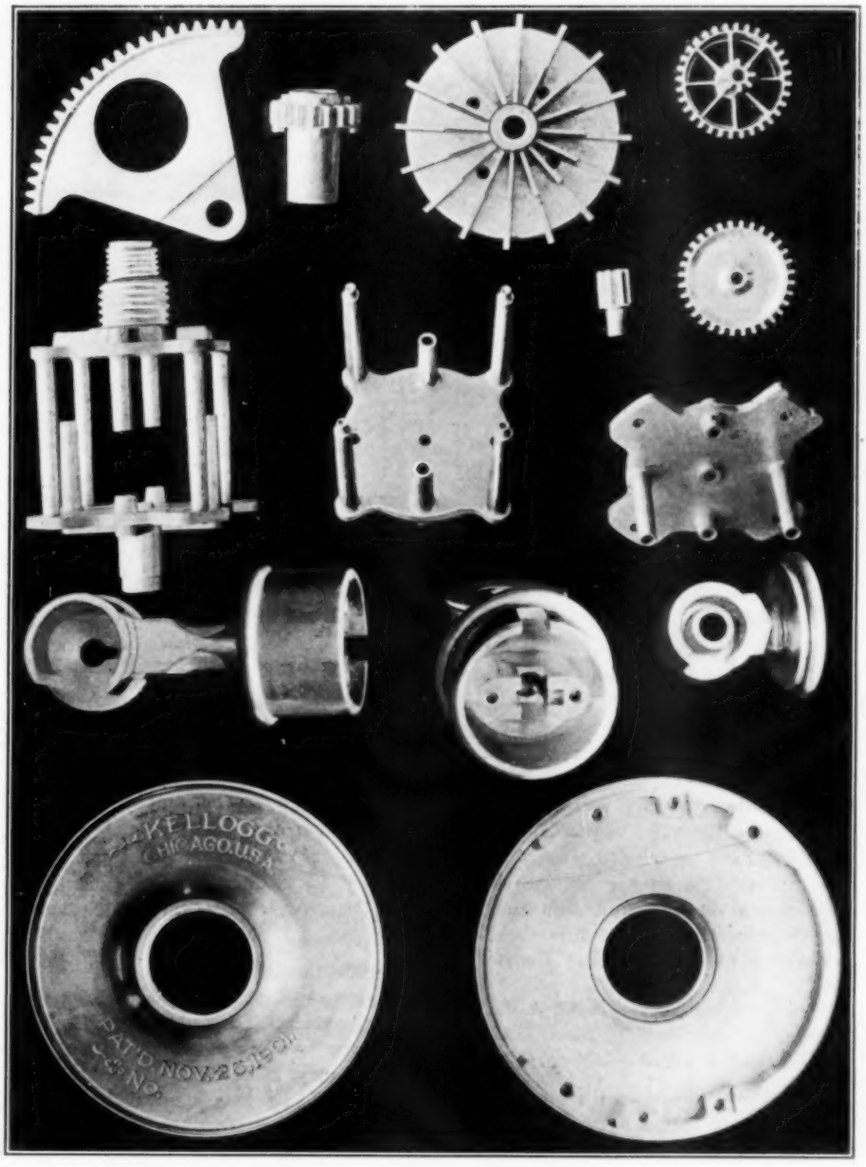

FIG. 3. AN ASSORTMENT OF DIE MOLDED CASTINGS

strength obtained thereby. The Veeder company has three grades of metal. The most commonly used is its softest mixture, called No. 1 metal, which can be readily spun or riveted. The medium hard metal can be spun slightly and is stronger and wears better than the No. 1 metal. The hardest metal is used mostly for pieces that must withstand compression. This grade is too brittle for spinning.

The use of die-molded castings is confined to parts which are required in large numbers. This is due to the cost of the dies. These must be made in steel with the greatest care, a variation of one-thousandth of an inch being the maximum allowable variation from dimension in many cases, and in some cases less than this is allowed. The advantage derived from this extreme accuracy is very great when many pieces are required, because it insures the correct fitting of the parts and saves time in assembling them.

One of the advantages of die-molded castings is the saving of special machinery. As the pieces are finished to exact size it is not usually necessary to do much work on them, hence the cost of any special machinery is saved as well as the necessary space and power for such machinery.

Another advantage is the rapidity of production, as automatic casting machines can be used to make a great many pieces in a day, so that orders for large quantities of castings can be filled in a few days after the dies have been made.

In making die-molded castings there is no waste metal, as the pieces are finished when they come from the dies and there are no chips to be saved and stored. Thus the metal in the finished pieces and the die molds are practically all of the cost, as any scrap made in getting out these pieces can be melted over at slight cost. Fig. 3 shows a number of castings made for various purposes by this process.

Offsetting Cylinders in Automobile Engines

Real Advantages: A Reduction in Frictional Losses, Thus Longer Life, and in Maximum Side Pressure of Piston, Thus Saving in Weight*

BY PROF. T. M. PHETTEPLACE

A great deal has been said recently about the offsetting of cylinders in single-acting engines and many claims of superiority are made by those who employ this form of construction. About twenty-five manufacturing establishments in the United States are building engines in which the cylinders are offset, chiefly those of the automobile type, and one company is formed for the purpose of making engines in which the offset is equal to the crank radius and the connecting rod length is about 3⅜ times the crank radius. Among the claims made by manufacturers for offset engines are: greater power, less side-pressure of the piston on the walls of the cylinder, better turning effort, less vibration, smoother running qualities, and when one cam shaft is used, a more convenient mechanical arrangement.

On account of the importance of this subject and the lack of information concerning it, a complete discussion is desirable and is here presented.

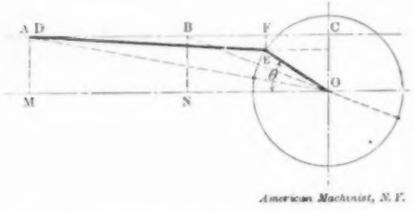

FIG. 1. DIAGRAM OF OFFSET CRANK AND CONNECTING-ROD TRAIN

The cylinder of an engine is said to be offset when its centerline is not in a plane through the center of the crank shaft. The practice is not new and is applied to both steam and gas engines having one or any number of cylinders. In the diagram, Fig. 1, $A\,B$ represents the stroke, $O\,E$ the crank radius, $D\,E$ the connecting rod, θ the crank angle, and $O\,C$ the offset. It should be noticed that θ is the angle the crank makes with a line through the center of the crank shaft parallel to the center-line of the cylinder, and not the actual angle passed over from the inner dead point. The length of the stroke is

$$A\,B = R\sqrt{(a+1)^2 - k^2} - \sqrt{(a-1)^2 - k^2},$$

which is greater than 2 R.

R = crank radius.

$$a = \frac{L}{R}.$$

L = connecting rod length.

k = offset divided by R.

Thus for 3-in. crank radius the strokes would be as shown in Table 1. The distance to the end of the stroke farther away from the center of the crank shaft is shortened, thus $O\,M$ is less than $D\,E + E\,O$ or $L + R$ which affects the hight of the engine.

Ratio L/R	Offset R.	Stroke.	Increase Per Cent.
Any	Zero	6.00000	0.00
3	0.10	6.00375	0.06
3	1.00	6.42279	7.04
4	1.00	6.21180	3.50
5	1.00	6.12930	2.15
6	1.00	6.08730	1.01

TABLE 1. INCREASE IN STROKE FOR OFFSET CRANK OF 3 INCHES RADIUS.

The dead points are not opposite each other, so that the crank angle swept over while the piston makes the out-stroke is less than that for the in-stroke, causing a quick return motion and an average velocity for the in-stroke or compression and exhaust strokes greater than for the out-stroke, or explosion and suction strokes.

An expression for the piston in terms of the crank angle θ is developed in the usual way and is

$$\frac{X}{R} = \sqrt{(a+1)^2 - k^2} - \cos.\theta - \sqrt{a^2 - (k\ \sin.\theta)^2},$$

in which X = the piston displacement from the end of the stroke farther from the crank shaft.

The force of inertia due to the reciprocating parts is equal to the weight multiplied by the acceleration divided by 32.2. The value for the acceleration is found by differentiating the expression for the piston displacement twice with respect to the time. Substituting an approximate value of the radical in the expression for the piston displacement and differentiating twice with respect to the time gives

$$\frac{F}{A} = 0.00034\,\frac{W}{A}\,N^2\,R\,(a^{-1}\,k\,\sin.\theta + \cos.\theta + a^{-1}\cos.2\,\theta),$$

which is the expression for the inertia force per square inch of piston-head area when there is an offset.

A = Area of piston head,

W = Weight of the reciprocating parts,

N = Revolutions per minute,

R = Crank radius in feet.

This differs from the similar expression when there is no offset by the addition of the term $a^{-1}\,k\,\sin.\theta$, so that tables for inertia factors for no offset may be used by adding the value of this term.

The expression for the tangential pressure or the turning force for any offset is

$$T = P\left(\sin.\theta + \cos.\theta\,\frac{\sin.\theta - k}{a - \frac{1}{2}a^{-1}k^2 + a^{-1}k\,\sin.\theta - \frac{1}{2}a^{-1}\sin.^2\theta}\right)$$

in which P is the pressure on the piston pin in the direction of the center of the cylinder. This is a long expression to solve and a graphical solution may be followed if preferred. The work of solving the expressions for inertia force and tangential pressure may be somewhat lessened by tabulating the quantity $a^{-1}\,k\,\sin\,\theta$ which appears in these expressions.

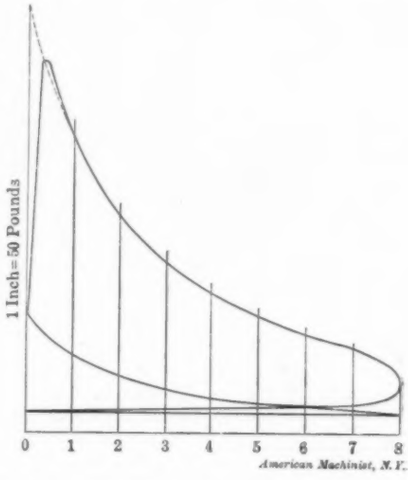

FIG. 2. OFFSETTING CYLINDERS IN SINGLE-ACTING ENGINES

Gasolene card—Compression, 70 pounds; maximum pressure, 259 pounds; pressure ratio, 3.77.

Side Pressure of Piston on Cylinder Walls

A reduction of the side pressure of the piston on the cylinder walls is one of the advantages claimed for offsetting. There are two ways in which the side pressure may meet the single-acting engine: (*a*) The maximum value of the side presure determines the length of piston to keep the maximum pressure per square inch of projected area below a value which is assumed as not too great

*Abstract of paper presented to the American Society of Mechanical Engineers.

to destroy the oil film between the rubbing surfaces; (*b*) the average value of the side pressure produces the friction between the sliding surfaces causing a mechanical loss and some wear of the parts. The loss in mechanical efficiency is more important than the wear, especially in the small high-speed automobile engines.

The average side pressures may be found by adding all of the areas between the axis and the curve of side pressures and dividing by the total length, or the areas themselves may be taken for comparison, as they represent the work done on the side of the cylinder by the piston, which is lost work and should be kept as low as possible. Curves of side pressures of the piston on the cylinder walls were constructed, it being necessary (*a*) to assume a gas card, (*b*) to assume engine dimensions, (*c*) to calculate inertia forces and plot curves, (*d*) to combine inertia forces with gas pressures, obtaining the force at the piston pin, and then (*e*) to determine the side pressure component perpendicular to the center line of the cylinder for the changing angularity of the connecting rod. The gasolene card chosen is shown in Fig. 2. As it seemed desirable to investigate two similar cases, one for high speed and the other for slow speed, the dimensions given in Table 3 were chosen.

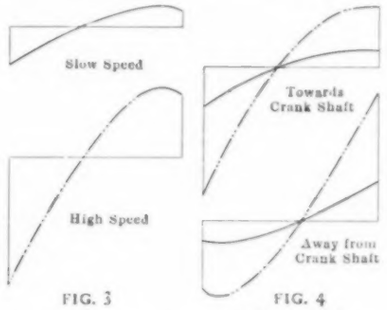

FIG. 3 FIG. 4
Offset = 0.50 R.

Curves of Inertia Forces on Piston Position Base

Slow Speed: R.P.M. = 450, R = 5, $\frac{W}{A}$ = 1 Lb.; L ÷ R = 3.

High Speed: R.P.M. 1500; R = 2½; $\frac{W}{A}$ = 0.7 Lb.; L ÷ R = 3. Offset Zero.

Full Lines, Slow Speed; Mixed Lines, High Speed

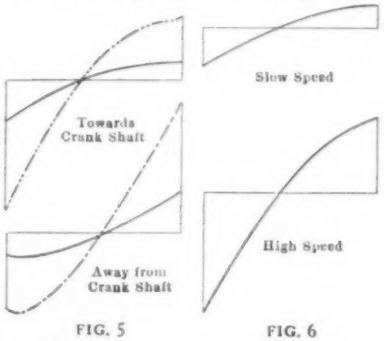

FIG. 5 FIG. 6
L ÷ R = 3. L ÷ R = 4½.
Offset = 0.50 R. Offset = Zero.

Curves of Inertia Forces on Piston Position Base

Specifications.	Slow.	High.
R.p.m.	450	1500
W/A	1 lb.	0.70 lb.
R	6 in. = 0.5 ft.	2½ in. = 0.208 ft.
0.00034W/A N²R	34.4	111.38

TABLE 3. DIMENSIONS ACCOMPANYING CARD OF FIG. 2.

Figs. 3 to 8 give the curves of inertia forces. The full lines represent the slow-speed and the mixed lines the high-speed cases. Inertia curves and side-pressure curves were plotted for ratios of $\frac{L}{R}$ of 4½ and 3, and for offsets of zero, 0.30 *R*, and 0.50 *R* for both high and slow speeds, making 12 cases in all. When there is an offset the inertia curve must be plotted for 360 degrees instead of 180, since for the return stroke it is not the reverse of that for the forward stroke, as is the case when there is no offset.

Comparing Fig. 3 with Fig. 6 a slight hump is noticed at the right-hand side in the former but not in the latter. This is probably due to error in the formula, for the small value of $\frac{L}{R}$ since the force could not be higher near the end of the stroke than at the end. The general effect of offsetting on the inertia curve is shown in Fig. 9, where the curves for $\frac{L}{R} = 3$, offsets = zero and 0.50 *R*, are compared, the curve for no offset being in full lines.

The curve for an offset is a little flatter near the end of the out stroke and the hump is increased near the beginning of the return stroke, which is probably due to inaccuracy in the formula.

The curves of side pressure are shown in Figs. 10 to 15. The maximum side pressure, its cause (whether combined gas and inertia pressure or inertia force alone) and its location are given in Table 6.

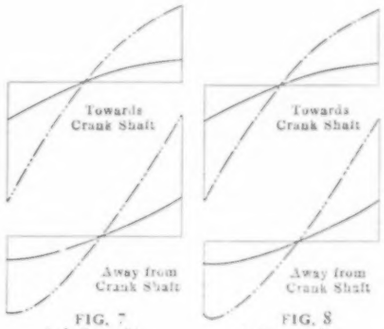

FIG. 7 FIG. 8
L ÷ R = 4½. L ÷ R = 4½.
Offset = 0.30 R. Offset = 0.50 R.

Curves of Inertia Forces on Piston Position Base

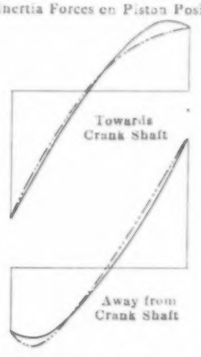

FIG. 9 Inertia Force Curves showing Effect of Offsetting L ÷ R = 3. High Speed. Full Lines, Offset = Zero; Mixed Lines, Offset = 0.50 R.

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Ratio L/R	Offset.	Max. Side-Pressure. Slow.	Max. Side-Pressure. High.	Due To Slow.	Due To High.	Stroke Slow.	Stroke High.
4½	0	25	26	Gas	Gas	1	1
4½	0.30 R	17	24	Gas	Inertia	1	2
4½	0.50 R	12	28	Gas	Inertia	1	2
3	0	35½	45	Gas	Gas	1	1
3	0.30 R	23	39	Gas	Inertia	1	2
3	0.50 R	20	51	Inertia	Inertia	2	2

TABLE 6. MAXIMUM SIDE PRESSURE AND ITS CAUSE.

From this for $\frac{L}{R} = 4\frac{1}{2}$, slow-speed, maximum pressure is lowest with 0.50 *R* offset, and if the offset were further increased the maximum side pressure would probably not be reduced as the values at the beginning of the second and fourth strokes would increase, and now they are already 11 so that any increase would soon cause an increase in the maximum value instead of a decrease.

In the case of $\frac{L}{R} = 3$ the lowest maximum value occurs when the offset is 0.50 *R*, but in this case it is possible that the offset is already a trifle large, as the maximum value occurs at the beginning of the second stroke, although it is not much greater than that in the first stroke, being 20 in the former case and 18 in the latter. Hence for the slow speed the best offset would seem to be about 0.50 *R* as far as the maximum value of side pressure is concerned.

In the case of $\frac{L}{R} = 4\frac{1}{2}$ high speed, the maximum side pressure due to inertia force at the beginning of the second stroke seems to increase with the amount of offset, while the maximum value due to the gas pressure in the first stroke seems to decrease with the increase in offset. These values are shown in Table 7.

$$\frac{L}{R} = 4\frac{1}{2}.$$

Offset.		Zero.	0.30 R	0.50 R
Side pressures due to	Gas pressure, 1st stroke	26	17	13
	Inertia, 2d stroke	15	24	28

TABLE 7. MAXIMUM SIDE PRESSURES.

Plotting curves of these values, the most favorable offset as far as maximum side pressure is concerned is 0.16 *R* when $\frac{L}{R} = 4\frac{1}{2}$. This curve is shown in Fig. 16.

See Table 8 for values $\frac{L}{R} = 3$. This would place the best offset for $\frac{L}{R} = 3$,

as far as maximum side pressure is concerned, as 0.20 R, which would seem to indicate that a greater offset would be desirable as the ratio $\frac{L}{R}$ decreased. It remains to determine if possible the best offset as far as the work done in side pressure is concerned.

Offset.		Zero.	0.30 R	0.50 R
Side pressures due to.....	Gas pressure, 1st stroke....	45	30	20
	Inertia, 2d stroke....	25	39	51

TABLE 8. SIDE PRESSURES.

Ratio L/R	Offset.	Slow Speed.				High Speed.			
		+Area.	−Area.	Total Area.	Average Side Pressure.	+Area.	−Area.	Total Area.	Average Side Pressure.
4½	0	1.61	−0.53	2.14	6.6	2.33	−1.11	3.44	10.7
4½	0.30 R	1.09	−0.90	1.99	6.2	1.78	−1.58	3.36	10.5
4½	0.50 R	0.74	−0.93	1.67	5.2	1.62	−1.90	3.52	11
3	0	2.59	−0.92	3.51	11	4.11	−1.45	5.56	17.3
3	0.30 R	1.55	−1.15	2.70	8.4	3.01	−2.76	5.77	18.0
3	0.50 R	1.11	−1.39	2.50	7.8	2.47	−3.40	5.87	18.3

TABLE 9. AREAS AND AVERAGE SIDE PRESSURES.

The work done is proportional to the areas included between the axis and the curve of side pressures. It seems to make no difference whether a larger amount of work is done on one side than on the other, or in other words there seems to be no advantage in having the work done on each side the same, unless at some time it might be desired to rebore th cylinder, in which case wear occurring all on one side might have left the walls too thin or might necessitate the removal of much more metal.

Table 9 shows the results of measuring the areas, namely the ratio of work done in one case to that in each of the other cases, and also the actual average side pressures. For the slow-speed case there seems to be a decrease of work done on one side, and an increase of work done on the other side, resulting in a decrease in the total work done with the offset, which would indicate that the greater the offset, the less the loss in work. The average side pressure also decreases with the offset, although it is less with no offset when $\frac{L}{R} = 4\frac{1}{2}$ than with 0.50 R offset when $\frac{L}{R} = 3$.

In the case of the high speed the areas on one side decrease with the offset while those on the other side increase, but the totals for $\frac{L}{R} = 4\frac{1}{2}$ decrease and then increase, while for $\frac{L}{R} = 3$ they continue to increase, and, of course, the same is true for the mean side pressure.

This would seem to indicate that there is little if anything to be gained by an offset in regard to work done by the piston on the walls of the cylinder when the inertia force is very high, since what is gained on one side is more than made up in loss on the other side. If it is of sufficient importance to have the work done on each side of the cylinder the same, we may plot curves of the work done on each side and note where they intersect, as in Fig. 17. In the case of the slow speed we would have the work done on each side equal when the offset was about 0.40 R and in the high speed this point would be about 0.36 R.

Thermal Cycle. Offsetting increases the length of stroke, which gives increased expansion to the gas, and increases the piston velocity on the instroke, giving greater inertia to the gas on the exhaust and reducing the amount of leakage by the piston on the compression stroke. This refers to the 4-cycle gas engine.

Lubrication. The curves of side pressure show the manner in which the side pressure changes sides, which is a good thing for lubrication. This changing sides would be about the same for offset or no offset except in the case when the offset is equal to the crank radius. Here the pressure is almost continually on one side of the cylinder so that oil would with difficulty be introduced between the surfaces. Other things being even, except for this extreme case, the reduction in amount of side pressure should make lubrication more satisfactory.

Vibration and Balance. Revolving masses and reciprocating masses may cause vibration in gas engines. Offsetting the cylinders would not affect the revolving masses at all but does change the curves of inertia forces, as already shown in Fig. 3 to 8. These inertia-force diagrams are now combined in different ways according to different arrangements of cylinders, and are compared with similar curves when there is no offset.

The following applies only to the 4-cycle type of gas engine, whose arrangements are:

a Single cylinder.
b Two-cylinder vertical.
c Two-cylinder opposed.
d Three-cylinder vertical.
e Four-cylinder vertical.
f Four-cylinder double-opposed.
g Six-cylinder vertical.

General Conclusions

The following are perfectly general conclusions, to be followed by a more definite comparison of actual engines.

a The length of stroke for a given crank radius increases as the offset increases.

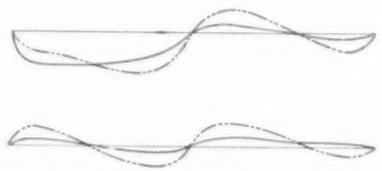

FIG. 10 Curve of Side Pressures on Piston Position Base
C ÷ R = 3, No Offset.
Full Lines, Slow Speed. Mixed Lines, High Speed

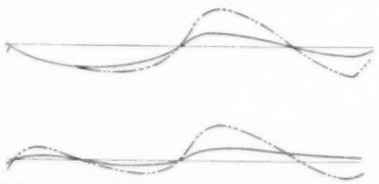

FIG. 11 Curve of Side Pressures on Piston Position Base
L ÷ R = 3, Offset = 0.30 R.
Full Lines, Slow Speed; Mixed Lines, High Speed

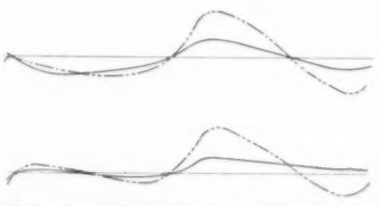

FIG. 12 Curve of Side Pressures on Piston Position Base
L ÷ R = 3, Offset = 0.50 R.
Full Lines, Slow Speed. Mixed Lines, High Speed

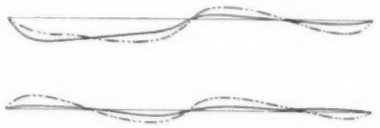

FIG. 13 Curve of Side Pressures on Piston Position Base
L ÷ R = 4½, Offset = Zero.
Full Lines, Slow Speed; Mixed Lines, High Speed

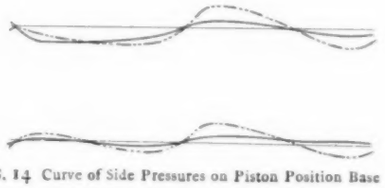

FIG. 14 Curve of Side Pressures on Piston Position Base
L ÷ R = 4½, Offset = 0.30 R.
Full Lines, Slow Speed. Mixed Lines, High Speed

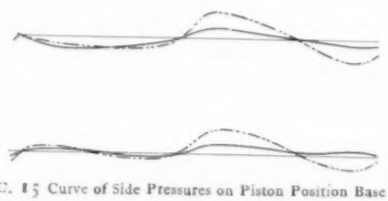

FIG. 15 Curve of Side Pressures on Piston Position Base
L ÷ R = 4½, Offset = 0.50 R.
Full Lines, Slow Speed; Mixed Lines, High Speed

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b The length of stroke for a given crank radius for any offset decreases as the ratio of $\frac{L}{R}$ increases.

c The increase in length of stroke causes an increase in average piston speed.

d Offsetting the cylinders makes the crank and connecting rod train a quick return mechanism.

e When the cylinders are offset the crank passes over an angle greater than 180 degrees during the out-stroke of the piston, and less than 180 degrees during the in-stroke.

f The average velocity of the piston is greater on the exhaust and compression than on the explosion and suction strokes.

g Offsetting the cylinders reduces the angularity of the connecting rod on the out-stroke and increases it on the in-stroke.

h When there is an offset, the side-pressure of the piston on the cylinder walls does not change sides at the end of the stroke, but just after the beginning and just before the end of the out-stroke.

i The place where this change of side-pressure occurs approaches the middle of the stroke as the amount of offset approaches the crank radius.

j With no offset, high inertia forces do not greatly increase the maximum side-pressure during the explosion stroke, but do increase it considerably, during all of the other strokes, and this effect is slightly greater as the ratio of $\frac{L}{R}$ decreases.

k With no offset the work done increases with the inertia-force and as the ratio of $\frac{L}{R}$ decreases.

l For low inertia forces, as far as the maximum value of side-pressure is concerned the best offset is one-half the crank radius.

m Considering the maximum value of the side-pressure only, the most favorable value for the offset decreases as the inertia-forces increase, for any ratio of $\frac{L}{R}$ but does not decrease as rapidly, for smaller values of the ratio $\frac{L}{R}$.

n For low inertia forces, the work done by the piston on the cylinder walls decreases as the offset increases, but, of course, is greater for smaller values of $\frac{L}{R}$.

o For very high inertia forces, the work done decreases slightly with the offset up to 0.40 of the crank radius for value of $\frac{L}{R} = 4\frac{1}{2}$.

p For very high inertia forces, and small values of $\frac{L}{R}$ there is no advantage in an offset, as far as the work done by the piston on the cylinder walls is concerned.

q The thermal cycle is slightly benefited by offsetting and the benefit increases with the amount of offset.

r Lubrication should be slightly improved by offsetting the cylinders.

s Vibration due to the free inertia forces is no different except in the case of a two-cylinder opposed or four-cylinder double-opposed motor.

Study of Commercial Engines

A detailed study of several commercial engines shows that the most desirable offset seems to be as much as can be practically obtained with ratios of $\frac{L}{R} = 4$ and greater, with a decided gain over an

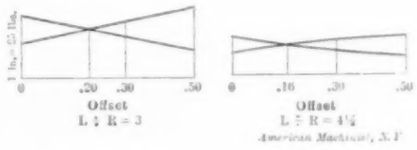


FIG. 16. CURVE SHOWING VARIATIONS OF SIDE PRESSURE WITH OFFSET

engine with no offset for speeds less than 1400 to 1500 revolutions per minute. The subject may be summed up as follows:

Improvements due to offsetting, (1) in the thermal cycle, (2) in the mechanical arrangement, (3) in the turning-effort curve, and (4) in lubrication, are very slight and may be neglected.

The real advantages are:

a A reduction of the frictional losses due to the pressure of the piston on the walls of the cylinder, resulting in a slight increase in mechanical efficiency and less wear of the piston, piston rings and cylinder, and consequently longer life.

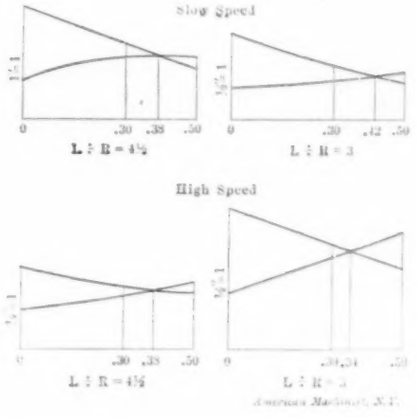


FIG. 17. CURVES SHOWING OFFSET WHEN WORK IS SAME ON EACH SIDE OF CYLINDER

b A reduction of the maximum value of the side-pressure of the piston on the walls of the cylinder, allowing the use of shorter connecting rods, shorter pistons, and shorter cylinders, resulting in a shorter and lighter engine and in lower inertia forces due to the reciprocating parts. The most important of these advantages would be a considerable saving in weight.

The disadvantage of offsetting lies in the fact that the reductions in average side pressure and maximum side pressure grow less as the speed and inertia force increase, so that for a speed of 1400 to 1500 revolutions per minute there is either no reduction at all or an increase.

Principal Conclusions

Offsetting increases slightly the length of stroke and the crank angle passed over during the stroke toward the crank shaft.

The maximum value for the side pressure of the piston on the cylinder walls decreases as the offset increases up to a value of one-half the crank radius for any ratio of $\frac{L}{R}$.

The work lost in friction due to the side pressure of the piston on the cylinder walls decreases as the offset increases up to a value of 75 per cent. of the crank radius.

Both the maximum value of the side pressure and the work lost in friction increase as the value of the ratio $\frac{L}{R}$ decreases.

Offsetting decreases the hight and weight of the engine.

Offsetting increases the life of the cylinder and piston.

Offsetting improves the thermal cycle.

The turning-effort curves when the cylinders are offset differ but slightly from those for no offset.

The advantages of offsetting as regards the maximum side pressure and work lost may be zero or negative for high inertia forces resulting from speeds of 1500 revolutions per minute or more.

As respects kerosene and gasolene in lubricating oil, it is enough to say the oil is ruined for the purpose of lubricating if it is thus diluted. Proof of this is given in the plan by which kerosene is used in oil for multiple-disk clutches if the clutch will not hold. In a word, lubricating oil in the clutch is too slippery, and kerosene is added to diminish the unctuousness on the one hand, and a still more important property on the other, namely, the ability of lubricating oil to persist in remaining between two surfaces under great pressure. In the case of the clutch it is desired to have the oil squeeze out from the disks with ease. This ease would be ruinous to a crank-shaft bearing, as will be self-evident.

Constantly feeding kerosene to the cylinders of a motor, even if the same is sneaked in with the lubricating oil, is bound to result in the unbalancing of the explosive mixture, and, too, it is plain that the question of "carbon deposit" will be rendered the more prominent as well as many other ills developing from such practice.

The Maxim Gun Silencer

By Frederick M. Bush

Since gunpowder was invented, man has sought for more and more deadly ways of using it; the match-lock gave place to the flint-lock; that was followed by the percussion-lock, and the chain was continued by breach-loading, repeating, semi-automatic and automatic guns, until at the present day one wonders why the casualties of war are so low and why any game is left in the woods.

In the line of ammunition the advent of smokeless powder marked a great advance, not only in very materially reducing the smoke cloud always attending the burning of black powder, but due to peculiar characteristics, it made higher pressure of gases possible, thereby increasing the range and accuracy by flattening the trajectory of the bullet through increasing the velocity. Of course, the penetration was greatly increased, too, so that the old Indian method of firing from behind a tree might be disappointing to the Indian, providing he chose a yellow pine of, say, less than 4 feet diameter—and his enemy could hit the tree.

But still there is the report or concussion of the air caused by the gases issuing from the gun at a very high velocity. Now, if this velocity can be reduced obviously the report will be reduced also.

From this point of view the problem was attacked by Hiram P. Maxim, of Hartford, Conn., ignoring past attempts to shut off the escape of the gas by means of valves or similar unsatisfactory contrivances; and while it is too much to prophesy that the report will ever entirely pass, and perhaps it is as well that it should not, a great step has been taken in that direction in what has been spoken of as the Maxim noiseless gun, but which is in reality a device for attachment to any gun and is called a "silencer."

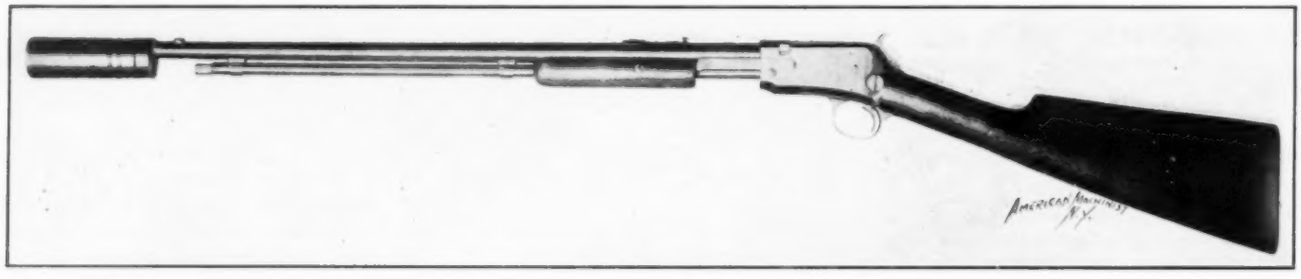


FIG. 1. RIFLE WITH SILENCER ATTACHED

Construction of the Silencer

It is a cylinder screwed by a thread, interrupted or continuous, to the muzzle of any ordinary single-barreled gun and removable at will. Within the cylinder is a series of deflectors, the number depending upon the size of the gun. These deflectors are formed up from sheet steel about 1/16 inch thick. The rim is turned over so as to have the cross-section of a semi-circle about ¼ inch inside diameter, and the central portion of the plate is raised to form roughly a cone. A hole some 0.03 or 0.04 inch larger in diameter than the bullet is drilled parallel to the axis of the deflector and in line with the bore of the gun. This hole is eccentric to the deflector so as to throw the silencer as a whole below the line of the sight. Leading to the hole, the cone is flattened to form an approximate spiral. Annular grooves are rolled or formed into the walls of the cylinder or cast to hold the deflectors from being blown out. The dimensions of the silencer are 1⅜ inches outside diameter, 6 inches long, and weighing 10 ounces for the high-power military rifle and 1⅜ inches outside diameter, 4 inches long and weighing 4 ounces for 0.22 caliber rifles.

Fig. 1 shows the silencer attached. Fig. 2 is a larger view of the silencer and muzzle of a Springfield rifle and Fig. 3 is a section on the center line of the drilled holes in a horizontal plane.

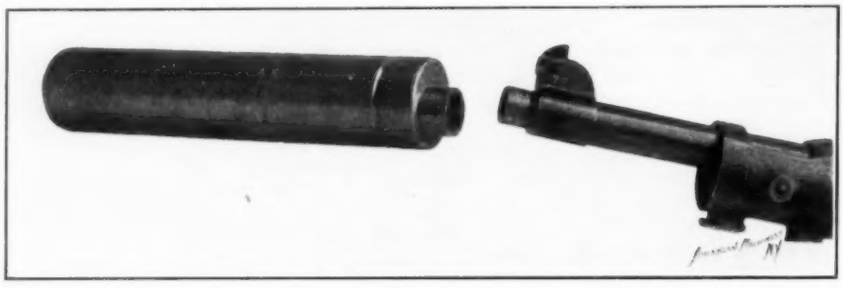


FIG. 2. METHOD OF ATTACHING THE SILENCER TO A RIFLE

Theory of the Silencer

It may be seen that a gas moving in a direction parallel to the axis of a deflector and striking its surface would be deflected first from the cone to the rim and then from the rim to the center. The particles of gas moving in this path would meet other particles moving toward the rim and a violent eddy would be formed which would absorb considerable velocity. The gas would finally escape through the orifice drilled in the plate if escape in other directions were prevented as in an assembled silencer. The approach to the orifice being roughly the shape of a spiral, the gas passes through the orifice not in a direction parallel to the axis of the deflector, but at quite an angle to it. This is shown by blowing smoke through a tube, the outer end of which has been closed by a deflector. The smoke issues at an angle of about 45 degrees with the axis of the tube. When the deflectors are mounted in a cylinder to form the complete silencer the eddying motion is repeated at each deflector, the movement being slower and slower as each deflector is passed.

As the gases issue from the muzzle of any gun they do not follow straight, though slightly diverging lines, as is usually supposed, but take the form of quite a flat mushroom. This action, together possibly with the plugging of the hole in each deflector as the bullet passes, and also the fact that when the bullet starts from the cartridge, the volume of air in the barrel and silencer is carried forward probably forming eddies in the silencer, are all accountable for the efficiency of the device as an absorber of the velocity of the gases.

An Interesting Test

At his laboratory Mr. Maxim made a number of tests for the writer with rifles of various calibers, and perhaps the most remarkable one showing the great reduction in velocity and blast was that of fastening a piece of moderately thick paper about 4x6 inches square approximately a foot in front of the muzzle of a Mannlicker rifle of the Austrian government pattern; this is a gun of very high power. Upon discharge the paper was blown to atoms. A silencer was then put on the same gun, a duplicate piece of paper was held at the same distance by

Mr. Maxim *in his fingers* while the writer fired the gun. The result is shown in Fig. 4. Except for some blackening by smoke for some 2 or 3 inches around the bullet hole the paper was unaffected.

An aural proof of what is accomplished was given with a 0.405 caliber rifle carrying a 300-grain bullet, and incidentally having a velocity of 2150 feet per second with an energy of 3077 foot-pounds at 50 feet from the muzzle and a penetration of 48 pine boards ⅞ inch thick. The gun was fired first without a silencer, and in the room where the tests were made the report was positively dangerous to the ear drums. A second shot was fired, as at first, but with a silencer in place, with the result that the discharge had entirely lost its characteristic suddenness and violence of concussion, and had become not unlike the discharge of an air rifle, or the disconnection of the air-brake line on a train of cars, though perhaps not quite so loud as the latter. This gun is one of the most powerful small arms that is made.

Effect of Silencer on Penetration, Accuracy, Etc.

The retardation of projectiles is due, not so much to the skin friction of the bullet in the atmosphere, as to a body of air piling up in front of the projectile in its flight, and to a certain extent being carried along with it also; and the theory has been advanced that the Maxim silencer would increase this retarding effect while the bullet is issuing from the gun.

Capt. Earl D. Church, of the ordnance department of the Connecticut National Guard, has just published in the *National Guard Magazine*, the results of a series of tests made by him to show the effect of the silencer on penetration, velocity, recoil, accuracy and sound reduction. The results under the first two heads may be questioned, as Captain Church had no facilities for making the tests on a scientific basis, but his results fail to show any loss in penetration or velocity, and if any such occur, it is fair to assume that they cannot be very great to have escaped detection. And when it is considered that the bullet is already clear of the barrel and out of reach of all accelerating influences except the slight one of blast, when the gas enters the silencer, it is hard to see where there is much chance for retarding effect.

The effect on recoil was found by Captain Church to be an appreciable reduction, and this is only what one might expect as the gas is tending to carry the silencer forward at a time when its pressure toward the breach has very materially lessened. In fact, this principle has been applied experimentally, at least, to larger guns, up to three-inch and possibly larger.

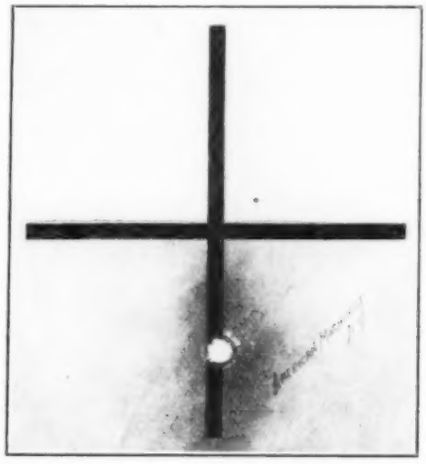


FIG. 4. EFFECT ON A CARD HELD ONE FOOT FROM MUZZLE OF A MANNLICKER RIFLE

The accuracy of an arm equipped with a silencer was tried out pretty well and no adverse effect could be discovered.

In the tests for elimination of sound, the experiments were thorough and reliable and show a reduction of 97 per cent. when measured by a machine for the purpose and a reduction of distance through which the sound could be heard of from three and one half miles to three-quarters of a mile. In both the above results is included the noise of the bullet passing through the air and for the elimination of which nothing has yet been devised.

While the experiments have been carried on with small arms of the military and sporting types, in calibers and charges varying from the lightest to the heaviest, no reason has yet developed why guns of all calibers up to the heavy coast defense should not be equipped with silencers; though in the larger guns, it would seem that the more desirable object would not be sound reduction *per se*, but the lessening of the undesirable blast, which, if not constantly safeguarded, may cause very disastrous effects.

As a Gas-engine Muffler

Another field for the silencer may be that of a muffler of the exhaust of gas and gasolene engines. In this case Mr. Maxim claims great decrease of back pressure, though no tests are at hand in this connection, and the matter is still in an experimental stage.

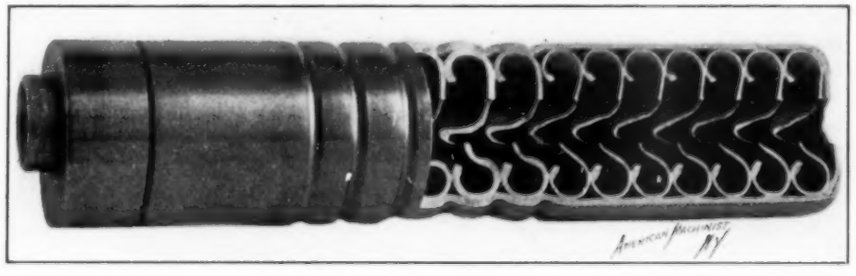


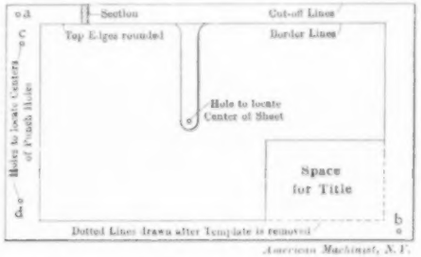
FIG. 3. SECTIONAL VIEW OF SILENCER SHOWING INTERIOR CONSTRUCTION

A Time Saver for the Drafting Room

By Wilbur C. Prior

The device shown in the line cut will be found very convenient for laying out standard-size drawings. After the paper is tacked to the board the templet is placed on it and brought into position by the T-square. It can be held in position by two thumb tacks through the small holes marked *a* and *b*. Now, by simply tracing around the edges with the pencil the drawing will be laid out.

If punch holes are to be located on the edge of the drawing for binding purposes these centers can be located by pricking through the templet with the divider point at *c* and *d*. If it is desirable to have the center of the sheet located, an ear can be made on the templet, as shown. A hole in this ear large enough for the divider point to pass through will locate the center. After the templet is removed the lines forming the title corner can be quickly completed.



A DRAWING SHEET TEMPLET FOR THE DRAFTSMAN

The templet should be made of sheet brass 3/32 of an inch thick, and will be cleaner and look neater if it is nickel-plated. The top edges of the templet should be slightly rounded to prevent them from cutting into the lead of the pencil.

This templet not only saves much valuable time, but insures that all the drawings will be of exactly the same size, which is quite an advantage if the drawings are to be bound or filed.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Boring Mill Jig for Eccentrics

The manufacture of large quantities of machine parts necessitates facilities for the rapid and accurate machining of such parts.

A boring-mill fixture for the rapid handling of large engine eccentrics is herewith shown. As will be noted it is a very simple, durable fixture.

Fig. 1 shows the device in elevation on the boring-mill table with five eccentrics strapped to it by means of two studs passing through cored holes of the eccentrics.

The eccentrics, of course, have been machined on the sides first.

Fig. 2 shows a plan view of the work and fixture on the boring-mill table.

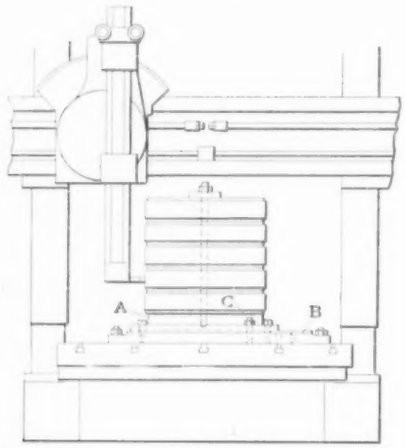


FIG. 1

FIG. 2

A BORING-MILL FIXTURE FOR ECCENTRICS

The fixture is in two principal parts, the upper part *A*, upon which the work is directly fastened, and the lower part *B*, which is centered and bolted down to the boring-mill table. Part *A* is provided with a keyway to fit the key on *B* so as to permit sliding *A* on *B*.

In the turning operation, the relation of part *A* with *B* the center of outer diameter coincides with the center of boring mill. This relation is assured by means of a taper dowel pin *C* and cap screws which are tapped into *B*.

For the boring operation, cap screws and dowel are backed out and the plate *A* carrying the work is shifted over so that the center of bore coincides with center of table and again positively located by means of dowel and cap screws. It is advisable to have two plates *A* so that after boring and turning, the work may be placed all together on the keyseater, while the other plate is being used on the boring mill.

Milwaukee, Wis. H. L. RAMBO.

Drilling and Tapping Valve Stems

A very simple and effective device for holding different sizes of brass water-valve stems, while drilling and tapping the hole in the bottom for the small screw that holds the fiber washer in place, is in use in one of the large plumbing-goods factories.

The work is done by a boy, on a small two-spindle drill press, one spindle of which carries a regular twist drill, while the other carries a tap and an automatic reversible tap holder.

Fig. 1 will give an idea of the construction of the device. *X* is a cast-iron plate, which is bolted to the drill-press table. Into this plate is set a pin *B* on which is fitted the movable cast-iron arm *A*. In the movable end of the arm is placed a steel bushing *D*, which holds the valve stem *C*. Stops are so placed that when arm *A* is in position 1, the center of the valve stem is exactly under the drilling spindle, and when in position 2, it is under the tapping spindle.

Fig. 2 is a sectional view of a bushing *D* and valve stem *C* in position.

The bushings used are of tool steel, hardened and ground inside and out, and there is a bushing for each length and diameter of stem, or about thirty in all.

A slot is milled across the bottom of the bushing the width of the steel key *M*, which is also the same size as the square head on the valve stem. The key *M* is set across the hole in the cast-iron arm as partially shown in Fig. 1. When the bushing *D* is placed in the hole in the arm *A*, the slot in it fits over the key and prevents turning, and the square of the valve stem fitting into the slot from above also prevents the stem from turning. In this way both stem and bushing are easily removable but are securely locked when in position.

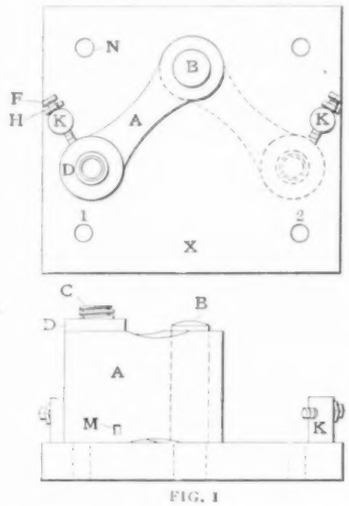


FIG. 1

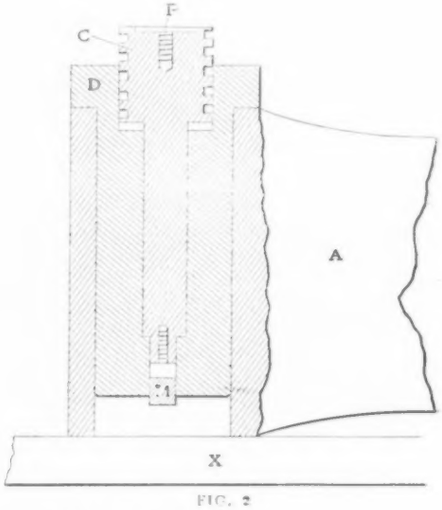


FIG. 2

DRILLING AND TAPPING FIXTURE FOR VALVE STEMS

By using this simple fixture a boy drills and taps the holes *P* at a rapid rate.

Another interesting device in use on a two-spindle drill press is a sort of four-hole vertical turret head, used for holding cast-brass nuts for drilling and tapping. For holding the nuts there is in each hole of the turret, a chuck consisting of a spring collet and a quick-acting screw cap, operated by a short hand lever set in the side.

The tools used are a drill in one spindle and an automatic reversible tap holder

and tap in the other, just as in the machine previously described.

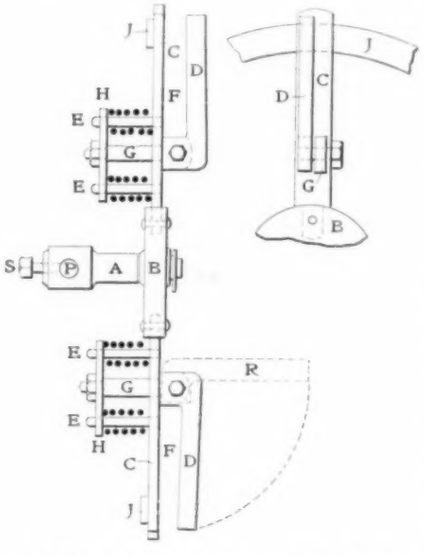
The turret is so set that as the operator sits in front of the machine, the drill is at the left and the tap at the right with a nut chuck under each, while directly in front is another chuck, the fourth chuck being in line directly back of the third.

A nut is placed in the chuck in front of the operator and the turret indexed one notch, which brings the nut under the drill. When this nut is drilled the turret is again indexed and another nut drilled, the first nut drilled lying idle until the third nut is placed under the drill, when the tap commences to work. After the third nut has been placed under the drill there is a nut drilled and one tapped at each indexing of the turret. As the drilling and tapping spindles both have automatic feed, and a nut can be put in the front chuck while the spindles are at work, the machine has quite a respectable output in a day's run.

Decatur, Ill. ETHAN VIALL.

A Reel Stand for the Power Press

In the shop I have charge of a deal of time was lost in placing the reels of metal in position for running through the press by means of a roll feed. This took from three to five minutes or more, so after some thought I had a stand made as shown in the line cut. By placing it on a round bar through the hole *P* in the axle *A* parallel with the press table it can be inclined to any angle and held by the set screw *S*. The opening of the spring latches



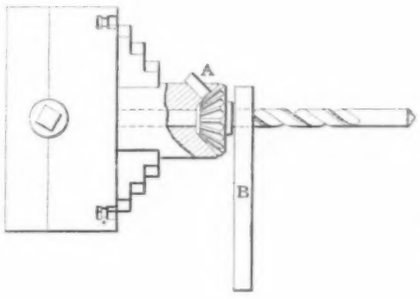
A REEL STAND FOR THE PUNCH PRESS

D D, four of which are employed, admits of placing on of a reel in about half a minute. The reels should be a loose fit to allow the blades to close easily. *A* is the axle on which the spider revolves, *B* is the boss carrying the flat iron rods *C C*, these being supported by a ring *J* riveted to the four rods. *G G* are knuckle end bolts holding the blades *D D* in position by the pressure of the springs *E E*. *G G* are squared on the end to fit a square hole in the pressure plate *H* and fastened by the nut. By making the blades a little closer at the points they will grip the reel enough to prevent it getting entangled on the outside of stand. Extra blades should be made for varying widths of metal.

Liverpool, England. W. EDGE.

Chucking and Drilling Bevel Gears

Having a lot of small bevel gears to drill and ream, as there was no time to make any elaborate fixtures for the job, I thought of the scheme shown by the sketch. The gears were rough castings of aluminum and quite irregular in size and shape on account of unequal shrinkage. The softness of the metal and an uneven number of teeth prevented holding them in a chuck, but they were wanted in a hurry and cheap, so this is the way it was done:



CHUCKING AND DRILLING BEVEL GEARS

A piece of round steel was put into the chuck and bored to fit the angle of the tooth face of the gears and a driving pin *A* put in one side, the end being flattened to go between the gear teeth. A hole was also drilled all the way through the piece for clearance for the reamer. The piece *B* was a short piece of flat steel held in the tool post and had a hole drilled through it central with the spindle to act as a centering guide for the drill.

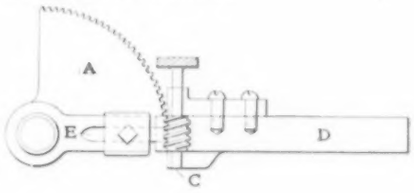
In operation the carriage was moved back to allow a gear to be put in place and then moved up, bringing the piece *B* in position to hold the work in the chuck, and also to center the drill. The drill was held in the chuck in the tail spindle and fed through by the right hand, while the left hand held the carriage from moving back. After a piece was drilled a movement of the carriage allowed the piece to drop out ready for the next one.

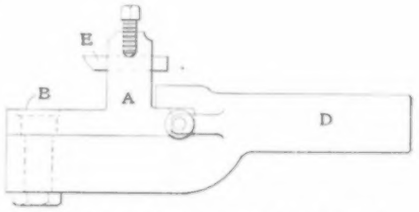
The pieces were all drilled first and then handled over a second time in the same manner for reaming and afterward faced on the end of the hub, using a counterbore with an extra long pilot and taking the piece *B* out of the way entirely. The cost of fixtures, of course, was almost nothing and the job first class.

Philadelphia, Penn. J. E. P.

A Tool for Turning Spherical Valves

It consists of a shank *D*, to which is pivoted a segment worm gear *A* which carries the cutting tool *E*. The segment is rotated by a worm *C*.





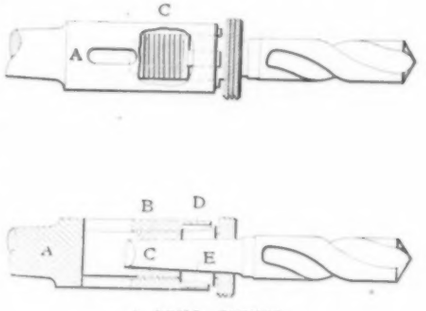
TOOL FOR TURNING SPHERICAL VALVES

As shown the tool is only adapted to turning valves but if the gear segment were made 180 degrees it could be used to turn ball ends and if the tool boss were located on the opposite side of the fulcrum stud *B*, it could be used in turning internal spherical surfaces.

Philadelphia, Penn. W. ALTON.

A Drill Socket

The illustrations show a drill socket which I have recently patented. It is intended to hold taper-shank drills or tools without the necessity of having a tang on



A DRILL SOCKET

them and will grip taper-shank drills having broken tangs. The body *A* is threaded at *B* to receive the threaded part *C* and recessed at *D* for a hardened steel bushing. The part *C* is slotted for hardened-steel jaws *E*, three of which are used, although the drawing shows four.

The drill is slipped into the socket and the moment the strain comes on it the part *C* running in the thread in *A* automatically tightens the grip of the jaws *E* on the shank of the drill. The drill is removed by a drift in the usual way and the piece *C* brought to normal position by hand..

CHARLES A. SIMMONS.

Albany, N. Y.

Setting Diamonds in Emery Wheel Dressers

I have often had trouble, after selecting a good diamond point, when closing the copper around the stone in having the stone move and thus change the position of the point. When a stone thus shifts it is difficult to get it back into correct position. I have found, however, that by melting a little wax around the stone (when set in correct position, using a hot wire on a piece of wax), when it is cool the copper can be calked in place without shifting the stone. As the copper is closed in the wax is squeezed out.

Cleveland, Ohio. ED. KRIEG.

A Fixture for Milling a Quick Pitch, Multiple Lead Screw

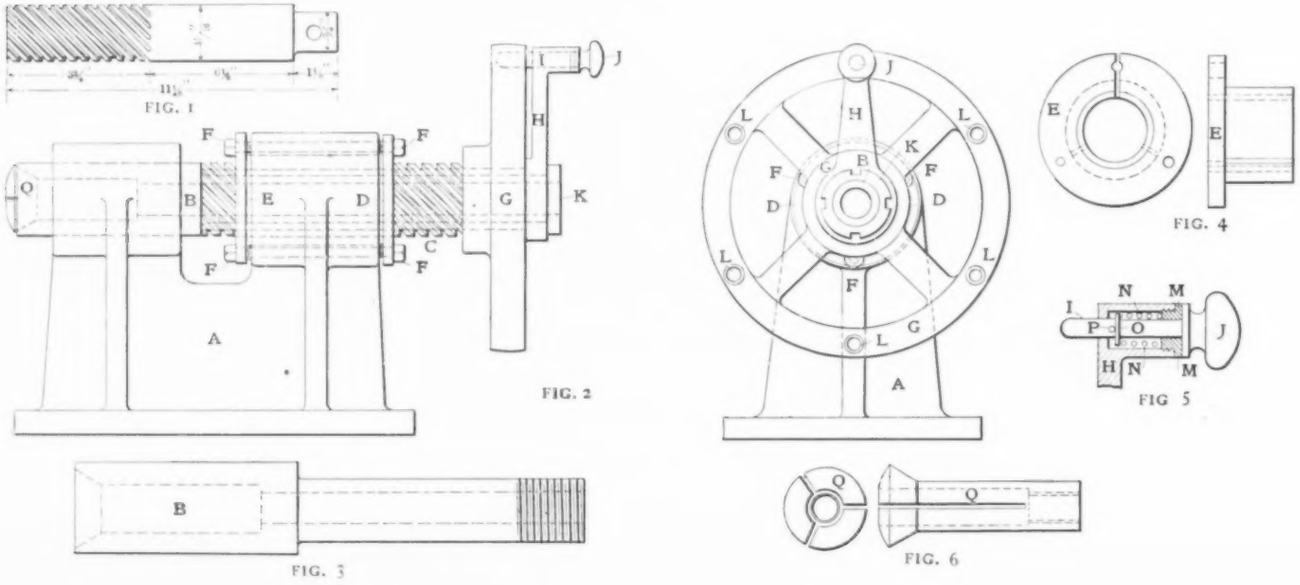
Fig. 1 shows a quick-pitch screw, with 6 threads, and 3-inch lead, made out of bright-drawn machinery-steel bar. Frequently having large quantities of these screws to cut, which had to possess a high degree of accuracy, for a complicated textile machine, we designed the fixture here shown, for milling the threads on a No. 3 Brown & Sharpe plain milling machine.

A, Fig. 2, is a gray-iron ribbed bracket, planed on the bottom, and bored out in the front top boss to receive the collet socket, or hollow sleeve, *B*, which is shown in Fig. 3. This sleeve has a reduced shank, which passes through the hollow guide screw, or former *C*, Fig. 2, which is cut the same lead as the work intended to be operated upon in the fixture. The guide screw works in bronze nuts *D* and *E*, also shown in Fig. 4. These nuts have means for taking up the wear on the thread. They are turned slightly taper on the outside, as shown in Fig. 4, the bracket being bored out taper to receive them; they are also split as shown, and as wear takes place on the former thread, the nuts *F*, Fig. 2, are adjusted on the threaded studs, which pass through the bracket, and draw the nuts, *D* and *E* together, thus taking up the end play of the screw, and at the same time closing the nuts in slightly, due to their being forced into the taper hole in the bracket. By this method the accuracy of the work is maintained, which with a solid nut would not be the case, due to the heavy end thrust on the thread in the nut. *G* is a dividing and hand wheel, keyed on *C*; *H* is a steel arm which is screwed on the spindle *B* and carries the spring plunger *I*, at the outer end operated by the knob *J*, also shown in detail in Fig. 5. *M* is a steel collar screwed in *H*, behind the coil spring, *N*, the other end of the spring pressing against the washer *O*, which in turn is forced against the steel pin *P*, which passes through the plunger *I*, and serves as a stop, by coming in contact with the bottom of the chamber. *K*, Fig. 2, is a locknut to prevent the lever *H* from slacking back. At *L* are six hardened steel bushes in the handwheel rim, for indexing the threads accurately, in which the spring plunger *I* operates. *Q* is the spring collet for holding the work; it is of the draw-in type and is also shown in Fig. 6. The back end is threaded internally as shown, and a long bolt passes through the hollow spindle *B*, and is tightened with a wrench at the back end; this bolt is not shown in the illustration.

In operation the fixture is secured on the milling-machine table, at the correct angle, which varies according to the pitch of the spiral to be cut; should the work project a long way out of the collet, it requires supporting with an adjustable vise block, or jack, to take the strain of the cutter and prevent springing. The cutter used is of the regular worm milling type, having sides at an angle of 29 degrees. and for very small, and fine threads it should be turned solid with the taper shank fitting in standard sockets in the milling-machine spindle. When the plunger *I* is located in the bush *L*, the spindle *B*, and master thread *C* both revolve as one unit, and a thread is reproduced on the work of exactly the same lead, and corresponding to that on *C*. To index the work for the next thread, all that is necessary is to disengage the spring plunger *I*, from the bush *L*, in the handwheel *G*, turn the latter to the next hole, drop the plunger in again, and proceed to mill the next thread. By changing the handwheel *G*, and substituting others with different numbers of index bushings, screws having any number of threads can be cut, but to alter the lead, it is necessary to remove the nuts, *D* and *E*, and also the master screw *C*, and replace them with those of the required lead.

With this fixture a youth can cut from 32 to 38 screws (like Fig. 1) per day of 10 hours.

Accrington, England. R. KIRKHOUSE.



FIXTURE FOR MILLING QUICK-PITCH MULTIPLE LEAD SCREW

Filing Clippings

I have seen several articles in the AMERICAN MACHINIST on the method of filing chippings out of the various technical journals, and no doubt my experience on this subject will be of interest to readers.

Some years ago I was a draftsman in a first-class machine tool firm, and noticed that one of the designers was always well up in the most modern design, and if I ever inquired of him if he knew a good idea for a certain job, he was always ready to supply me, and always knew where to look for the right thing.

When I asked him if he kept clippings, he answered that he kept all cuttings of interest and indexed them. This gave the cue, so I proceeded to have a system of my own.

Every week I go to the public reading room and take up all the technical journals which relate to the machine-tool trade. If there is anything that is worth having, I buy that journal from my newsagent, cut the interesting part out and file it away.

My method of filing is this:

I have several boxes 15 inches long and to take clippings 8x5½ inches. I fold them all 8x5½ inches, and number them on the top left-hand corner. I use a standard card index 5x3 inches for reference.

SPEED CHANGING DEVICES.

Speed Box on Vert. Mill (Newton)	114
Head of Horizontal Miller (Le Blond Motor Driven)	118
Speed Box of Drilling Machine	126
Cincinnatti All-gear Head (Miller)	56
Herbert's All-gear Head (Turret Lathe)	72
Handy Speed-changing Device (suitable for Grinder), A.M., Aug. 11, 1906	
"Engineer" Milling Machine. Supplement. 1907	120

FACSIMILE OF INDEX CARD

The numbers in the right-hand correspond to those on the top left-hand corner on the clipping. By the combination of the card index and clipping box, I can find any clipping I want in the space of a few seconds.

I have also a method of filing ads out of the AMERICAN MACHINIST. I use filing boxes to take foolscap size which can be bought anywhere for 30 cents. I put the advertisements I want to keep in folders and have the folders in alphabetical order.

They run thus:

Automatic Screw Machines.

Auto Machine Operations.

Drilling Machines.

Grinding Machines.

Grinding Machine Operations.

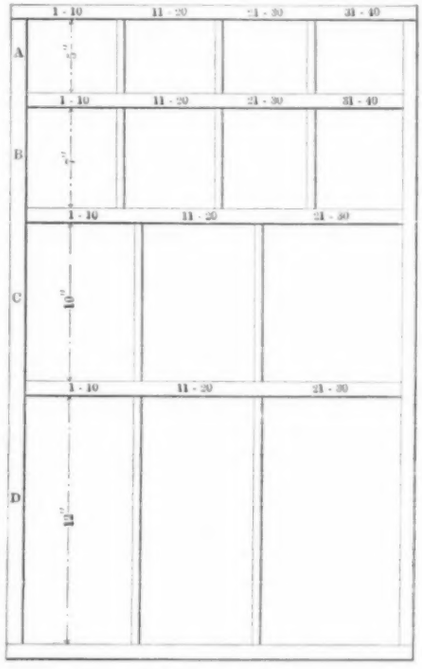
Milling Machines (Horizontal, Vertical and Various).

Milling Machine operations, etc.

By this means, I am able to refer instantly to an illustration of any modern machine tool which is on the market, because the machine tool which is not advertised in the AMERICAN MACHINIST is not worth considering. Those that come under the heading of "Auto Machine Operations" consist chiefly of the Cleveland Auto Machine Company's advertisements which appear on page 18 of the AMERICAN MACHINIST each week. I have the above firm's illustrations of operations from the first one. I have also a few of other makers.

I find these very useful if there is a piece of work to be machined which I think could be done cheaper automatically than by hand, by referring to these cuttings, I can get a good idea as to the time taken for this piece of work on an automatic.

As for the milling-machine operations, I have the Cincinnati Milling Machine



A CATALOG CABINET

Company's operations, which appear on page 7 of the AMERICAN MACHINIST, since they first started advertising them about four years ago.

I have also got others by Newton, Becker-Brainard, etc., and screw-milling operations by Pratt & Whitney, John Holroyd & Co., and others. I find this is a very comprehensive and simple way of filing advertisements.

Advertisements are regarded by many as so much waste paper but, personally, I find them a very useful and instructive part of the journal. I have the AMERICAN MACHINIST bound in half-years, complete from 1898 to date.

The method by which I secured the back numbers is rather interesting. While working in a works in Coventry, I used to ask some of the older hands if they had any old copies of the AMERICAN MACHINIST they wanted to dispose of. The reply invariably was "Oh, you have just come too late, I gave them to my little boy, and he sold about 2 hundredweight of them as waste-paper about a month ago, to a fried-fish shop near my house."

Instead of being discouraged in my quest, I at once proceeded to make a tour of the fried-fish shops in the city, and after about a month "on the road" I managed to get all the back numbers in splendid condition as far back as 1898.

Of course, I got a great number of duplicate copies but I took the lot, and after I got mine bound I sold complete duplicate volumes to fellow draftsmen.

I had four copies of the big issue of November, 1902, and sold them for 50 cents each. When I ask my fellow draftsmen, or shop men why they don't have their AMERICAN MACHINISTS bound, they reply "I don't think it's worth it. I make clippings of things that are of interest to me and put them on one side at home." On making further inquiries I usually find that the "putting on one side" usually consists of piling the clippings, one on the top of another, with no semblance of classification whatever.

When they happen to want a clipping it is then too much trouble to search through the pile to find it. When I ask them why they don't file them away, and have a card index, the usual reply is "It would take too much time for the little I use them." It does take time, but it is time well spent, and although one may only want to refer to a clipping occasionally, it might be worth dollars at that time.

With regard to classifying catalogs. I have made a case with four shelves, to suit the various sizes of catalogs. I have an index after the style of the AMERICAN MACHINIST with an alphabetical index and classified index of articles.

I put a small label on the top left-hand corner of the catalogs, and put on a number. The shelves being four in number I call them *A B C D*. I number the catalogs in rotation from left to right and start at No. 1 for each shelf.

For an example:

Brown & Sharpe Mfg. Company A.10
Hans Reinold. C.15

To facilitate reference, I have subdivided them into tens, placing partitions in the shelves, putting on a label as the illustration will show.

Being an I. C. S. student I have an arrangement for filing the answers to examination questions which will no doubt, be of interest to those of your readers who are taking I. C. S. courses.

I bought a file, foolscap size, of a concertina pattern, which is alphabetically indexed. When I receive my corrected answers I put them away in this and it is very handy for reference.

I should like to have other systematic fellows write and let readers know through your columns, the methods they employ.

Dudley, England. T. N. CHAMBAS.

A Special Milling Fixture for the Lathe

In Fig. 2 in sketch herewith, is shown a special lathe attachment for milling *C* and *D* on the castings, Fig. 1. They are made in large numbers and interchangeable. The casting is 26 inches high, 12 and 16 inches in diameter, and ¾ inch thick. The machined face of *C* is 1 inch wide and the vertical face of *D* is 1 15/16 inches. It is clamped down in the face plate and is automatically machined and stopped at the correct time. Many other jobs are done on this attachment. It is simple in construction and can be put on or taken off the lathe in a short space of time.

It consists of a cast-iron bed plate planed on top and machined at the bottom to fit the ways on the lathe. It is clamped to the bed by two bolts passing up through two flat straps at the bottom of the lathe bed. The plate is bored to receive the face-plate hub. The bearings *B*, 1, 2, 3, 4, 5, also the clutch bell crank, are secured to the top of the bed plate.

The worm wheel is machined all over and is bored to receive the face-plate hub; it is secured to this hub by set screws, the bottom face of the hub resting on the bed plate. The face-plate hub passes down through and is secured to the worm wheel, the lower end being loosely mounted in the bed plate. The worm has an extension sleeve, at the end of which is a miter gear secured by a set screw. The hub of the gear has a clutch which engages with a sliding clutch on the shaft, the sliding clutch being mounted on a feather.

When the clutch is engaged power is transmitted from the shaft through the clutch to the gear which drives the sleeve and worm. The worm is mounted on the bearings *B* 1, *B* 2, driving the face plate through the worm wheel. At the back end of the lathe spindle is a lock collar and disk combined. Power is transmitted from the lathe spindles through the connecting rod to the crank lever, which has a right-and-left pawl engaging with a loosely mounted ratchet on the shaft. The driving disk has a rotary motion, while that of the shaft crank is oscillating. The feed is regulated at the crank by a movable pin in a slot, also by a number of holes in the driving disk. These holes increase from the center by ¼ inch. The chuck is cast iron and has a threaded center hole to receive a threaded shank on the mill. This provides for adjustment and is locked by the collar, as shown.

When the clutch is disengaged the driving shaft is free to rotate in the worm driving the feathered clutch only, disengaging the pawl and ratchet stops, and the feed shaft altogether. With one or the other, or both disengaged, the face plate can be operated by hand by means of the feed shaft by placing a crank on the front end, as shown.

There is under construction the same design of attachment mounted on the carriage of the lathe so that boring and milling can be done.

Kenosha, Wisconsin. MACHINIST.

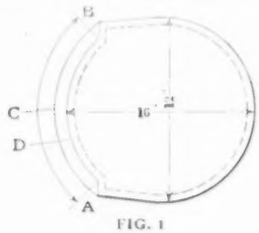


FIG. 1

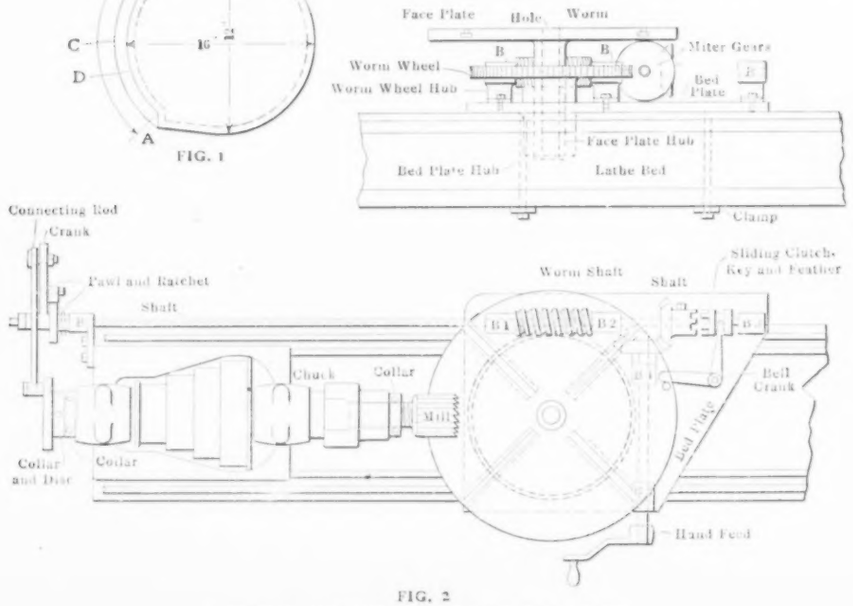


FIG. 2

A SPECIAL MILLING FIXTURE FOR THE LATHE

Cutting Threads on Taper Work

A few lines on the subject of taper-threaded work showing how we get different results in the angles of threads with the different settings of the thread tools may be of benefit to some of the younger machinists. Of course, it is understood that in all cases where we turn or bore a taper the tool must be set at the center, as there is more than one place at which the thread tool can be set; and there is also a difference whether the taper is made with a taper attachment or with the tailstock of the lathe set over. In the case of a lathe with a taper attachment we find that the center line of the work is parallel with the ways of the lathe; again, when we get our taper by moving the tailstock over we find that the center line of our work is not parallel with the ways of the lathe. The portion of the sketch, Fig. 1, at the left of the center of the taper piece shows the thread cut with the tool set at right angles to the center line of the work and the result is the same if we make the taper with the taper attachment or by setting over the tailstock. By drawing lines *A* and *B*, we find they will cross at the center line of the work. As we look at Fig. 2 at the right-hand side of the center of the taper piece shown, we find that in this thread, which has been cut with the tool set at right angles with the surface of the work, lines *A* and *B* do not cross at the center line of the work but a little to the side.

A. H. WALLBILLICH.

Tarrytown, N. Y.

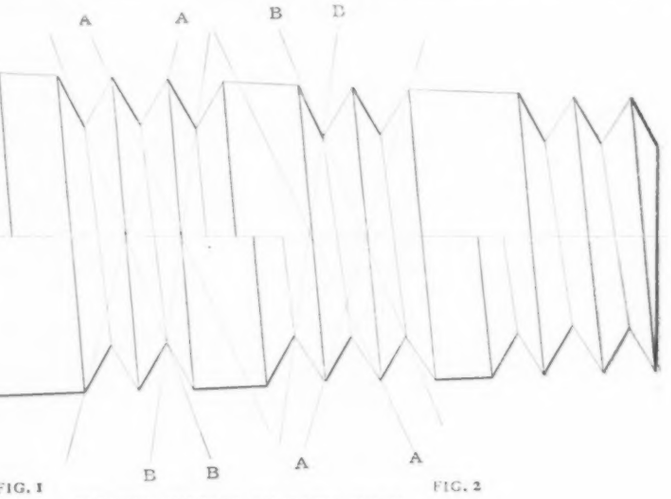


FIG. 1 FIG. 2

CUTTING THREADS ON TAPER WORK

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Bolt Heading Dies

The line cut shows a pair of 1¼-inch bolt dies. I have used all sizes of these dies from ¾-bolt to 2-inch, and know of several uptodate forge shops that use this particular form of die. It can be used in any heading machine. The line cut will show its superiority over the one you published on page 16, Fig. 2. With a set of these dies we make from 2200 to 2400 1¼-inch bolts 18 inches long in 10 hours, and could make 25,000 without sending the dies to the machine shop for repairs. We have a set of 1⅝-inch dies of the same pattern which have made 30,000 bolts at the rate of 1700 in 10 hours. We have not had them near the machine shop, and the dies are in good shape at the present time. I would call attention to the construction of the dies. They are known to boltmakers as the "three-lick die," as you can make a finished bolt with just three strokes of the machine.

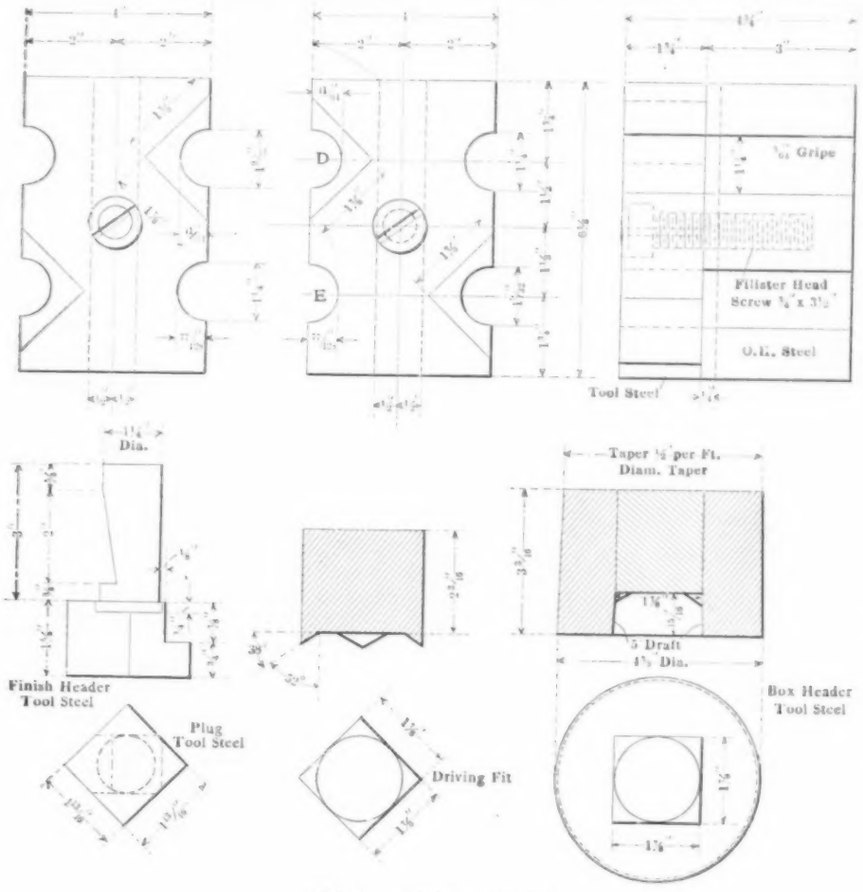


FIG. 1. A BOLT-HEAD DIE

The bolt is given one blow in the box header which forms the head; it is then placed in the square or finishing groove and given one blow, then turned and given a second blow, which makes the head perfectly square; by setting the plug in the box header any thickness of head can be made. It does not require an expert to make bolts on dies of this description.

The cost of redressing these dies is very small, and when properly set in the heading machine, I know of no other form of die that will make as many perfect bolts and as small a percentage of scrap.

The reason for using a plug and box header is to change the thickness of the bolt header should you desire to do so. Groove *E*, Fig. 1, has 3/64-inch grip so as to hold stock from slipping through the dies. Groove *D*, Fig. 1, is made 1/32 inch larger, which enables the bolt to slip back against the die, as shown at *A*, Fig. 2, and squares the neck of the bolt. *B* is the box header, and *C* is the finish header. The die is made in sections to reduce cost of machining.

Indianapolis, Ind. FORGEMAN.

Accurate Planing to Avoid Unnecessary Scraping

Having spent about 14 years running planers of different makes, and sizes, on a great variety of work in different parts of the country, any article on planing is of much interest. I do not agree with Mr. Knight when he says "It is impossible to run a cut of uniform depth across a surface with a tool slide as ordinarily constructed."

Mr. Knight does not state what kind of tool he used when making his experiment but only states that the standard depth of cut taken was 0.015 inch. Neither does he state what feed was used. He says the pressure at the tool point varied from 150 to 230 pounds with cast iron of various qualities, making from 10 to 15 pounds per 0.001 inch of cut. Wouldn't it be possible that if there was enough vibration to make the tool slide settle with the gib tight and the down feed screw in compression, that the vibration would have some effect on an instrument so delicate as to register the fractional part of a pound at the tool point?

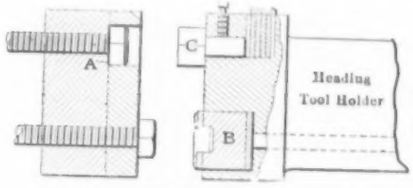


FIG. 2. SHOWING BOLTS IN HEADER

And again, would there not be the possibility of a difference in the density of the iron as the tool traversed the piece, that would cause a difference in the reading of the instrument? I believe there would.

About 5 years ago I was planing horizontal boring-machine tables, 24 inches wide by 6 feet long. These tables had to be very accurate as they were scraped to a surface plate. They were planed on a 48x48-inch by 12-foot Niles planer set on a stone and concrete foundation, there was practically no vibration. The planer was new, consequently everything about it was in very good shape. There is a 2-piece nut on this make of planer to take up the wear and it can also be used as a lock nut.

After much experimenting I found there was a much greater tendency to variation in the cut with this nut locked and the gib loose enough for the slide to settle of its own weight, than by having it the reverse, and there was a great tendency for the tool to chatter on the finishing cut.

I have seen "planer hands" drive the taper pin that holds the clapper, so tight into its seat that it was impossible for the clapper to settle of its weight. I have seen men do this and wonder why their finishing cuts were not even.

Ossining, N. Y. M. A. CHESTER.

Patent Experiences

A recent article on the above subject reminds me that I too have suffered from the disease. It attacked me first before I quitted my teens; and like some chronic malady still persists, after trying every remedy, even marriage.

Patent experiences! What inventor has been free? Oh! for some system of inoculation, which in its literal sense, will insert an eye into the inventor, an ordinary seeing eye, which will not at one and the same time both magnify and minish; magnify the importance of an idea and minish its drawbacks. Of patent experiences many have fallen to my lot; many are the snares and pitfalls that I could warn younger inventors against; but of what use are warnings? Still it may be of interest to some, possibly of profit to a few, to hear of my harvest of failures reaped and of ideals broken.

While still working out my indentures, some ill-advising friend (inventors always have plenty of these) persuaded me to enter a competition for 20 guineas offered by the Cyclist Touring Club of London. It was to be a contrivance for holding cycles in luggage vans. My invention consisted of an arm, hinged to the end of the van, which could be pulled down and hooked over the handle bar. Alas for me, I won the 20 guineas. For the first time in my life I realized how easy it is to make a fortune—in dreams. Unlike most first inventions it was both simple and effective, and has been used for years on certain railways. It died from exposure combined with constitutional weaknesses; its funeral cost me over £100. I attempted to make it and my fortune; what I should have done was to have invested the money and cherished the fond thoughts of what might have been. An idea unproved contains infinite possibility.

Good-bye fortune No. 1.

To anyone knowing the breed of inventors, it will not be surprising that a failure, which was nearly a success, did not discourage me. Following this the Patent Office did a roaring trade with me in provisional specifications. The subjects were varied, not to say absurd, having only one virtue, they kept me out of mischief and pocket money. Of course, with each application there came shoals of letters offering advice and help of all sorts. I answered one kind unknown friend, who wished to sell one of my patents for me, only to find, on making an expensive trip to London, that he proposed to open proceedings by getting a new patent out at my expense.

Meanwhile I made my living by inventing for others, sometimes with success, sometimes with failure, but always with profit to myself. This is the only inventing that sane men indulge in; they will be satisfied with their day's work for others, then go home and nurse the baby. It is far preferable to burying their shattered idols one by one.

But as I said, inventors are not sane, and soon I hit on something good. An ideal gear for motor cars, and, of course, for many other purposes. This cost me over £400 not counting the time expended; it was a beautiful thing. It had been invented before, it has been invented since. Only a year or so ago, the AMERICAN MACHINIST had quite a long discussion on it; I refrained from joining in because it nearly drove me to the madhouse, when working on it, and I got nearer a solution than the discussion did. Probably I am unique among the inventors of this perfect gear, in that I got prosecuted as a public nuisance for actually driving a car fitted with this gear through the streets of a well known city. It was a differential gear with the speed of one element varied by means of a shunt passing through a pair of friction cones. The power passing through this shunt was to be, and under some circumstances actually was, a negligible fraction of the total power, but unfortunately at times no power was left to drive the car.

While revolutionizing the motor-car industry, I patented an ignition plug, which could be easily taken to pieces and new parts fitted at the time of breakdown. It failed simply because some of the parts on breaking fell into the cylinder of the engine and caused indigestion.

I also patented an explosion motor with an impulse every revolution. This was never built; it cost me the least of all my patents, and the satisfaction is still left that it would work if tried. Instead I submitted it to expert criticism, and still cherish this document as a piece of courteous treatment and patient forbearance from one on whom I had no claims. So that too is dead, and "down among the dead men it shall lie."

I have had many other attacks of "patentitis," but these must wait.

York, England. Y. D. DIBBLEE.

Accuracy and Precision

In Entropy's article at page 140, the words "accuracy" and "precision" are used interchangeably. The late De Volson Wood, professor of mechanical engineering at Stevens Institute, was fond of illustrating the distinction between them by a little story. He told how once, on a surveying trip, a young man had sighted his instrument with the utmost pains and deliberation, adjusting it with punctilious care and aiming it at the very middle of the rod that served as a target. That was precision. He had, however, overlooked the fact that the pole at which he was sighting was a sapling ten feet away from the mark. That was not accuracy.

New York City. E. P. BUFFET.

Osborne's Peculiar Clock

The same clock, I believe, was doing duty in this city earning money for the inventor and advertiser. It was fastened to the plate-glass show window of an enterprising gents' furnishing house on the principal street of the city, and drew large crowds until the novelty wore off.

Being on the street one Saturday afternoon and seeing a crowd in front of the window I went to see what was the attraction; upon getting closer saw the clock, and pasted on the window under and alongside were cards stating that an explanation of what makes the clock go could be had inside, but not needing their line of goods I walked among the crowd listening to the comments on "what makes it go." There were all kinds of conjectures and if one-third of them had been incorporated in the clock it would have been a very complicated one instead of the simple one it was.

While I was standing there two friends came along and began discussing the problem. The two friends were draftsmen, while I profess to be a machinist. We came to the conclusion that there was only one way in which it could run and keep time, and have since demonstrated that we were right.

Like Mr. Osborne I will not explain how the clock keeps time, but will let the readers think it out for themselves. I believe the man that thinks for himself is worth more to his employer than the man who wants someone to explain how a thing must be done.

This brings to my mind incidents that are happening practically every day in the shops. The foreman assigns a piece of work to a man who has never done it before, but owing to conditions it is advisable to do it on his machine. Before he has taken time to consider it, he will say it cannot be done, or how are you going to do it as it has always been done on some other machine. He does not even stop to think that the foreman has seen a way to do it before he has made the assignment.

These conditions, I believe, are getting worse every day in our shops because we are not training our young men to be mechanics, and to learn to think for themselves, but bring in a driver of a coal wagon and put him on a machine and expect him to be a full-fledged mechanic in a week.

I do not mean by this that we do not make some good workmen in this way, but their field of usefulness is limited in a machine shop.

Holyoke, Mass. W. D. SNIDER.

Training Young Engineers

While one after another has written in the AMERICAN MACHINIST on the training of young engineers, I have looked in vain for any reference to what is possibly a most important aspect of the question.

For instance, I was apprenticed to a jobbing firm manufacturing gas cocks, lathes, roofs, cycle fittings, cocoanut machines, hand-beaten coronas for church ornamentation, gas engines, line shafting and printing machines.

I was at times in the drawing office and the pattern shop. I forged, turned, shaped, milled, drilled, erected in the shop, and when the job was completed, shouldered my kit and erected on delivery. Bad management! Yes, but was it bad training?

I know nothing of trade schools and technical colleges, but after a long day's work the privilege was open to pay my little pocket money at the night school for indifferent tuition. But still, sines and tangents and logarithms, that are easier to understand than to apply, have thus become easy to use.

How can I, with such training, hope to compete with those fortunates, whose parents have had both the will and the means of properly educating them under the professional shadow? What chance is there for me in the race for life? Well, to tell the truth, it is now over 10 years since I was out of my apprenticeship, and as I look around me at those who hold positions to which I aspire, there is not a college-trained man among the whole lot.

Then again, that fine list of certificates so neatly printed, I have never dared to show them after the first time. Employers never ask or care for certificated knowledge. Some, unfortunately for me, with jobbing-shop experience, ask where one has worked; these are not the best to work for. The best employer knows at a glance a trustworthy man, takes his word and expects him to make good.

The employer that it is a pleasure to work for (I prefer to say "with") is the one that understands human nature; he can make due allowance, knows when failure is to be censured and when condoned.

He knows who is fit for certain tasks, and who can bear responsibility for him. He can pick the best man for heaving a hammer, the best for light, accurate work, and he knows, too, those whom he can leave without fear of idling.

There are none too many of this kind; capitalism and limited liability is death to such. But after all the man who is successful in engineering is he who has added to more or less skill, first, energy; second, a knowledge of human nature; third, a broad love of humanity. Lacking any of these and especially the first, a man must have stupendous genius to make headway.

The way to cultivate these and improve our natural stock is not taught at our trade schools. Those who have them with average ability rise like a cork to the top. Those who lack remain below, know what they may. If a youth lacks in energy he must live hygienically, must keep his body in tone by judicious exercise and bathing, abstain from violent narcotics or stimulants such as tea, alcohol, much meat and tobacco, that he may have his little energy available and by conservation increase its effect.

If a youth lacks in love of humanity, he must force himself to work on its behalf and enjoy the company. If a youth lacks in knowledge of human nature what is he to do? Nothing? How do those read a man's character who do it instinctively? It is by certain features and expressions, mostly unrecognized but none the less there. If such a one could analyze his reasons, it would be found to be founded on solid fact that man carries his character written on his face that all who can may read.

London, England. C. F. BLAKE.

Parallel Depth Bevel Gears

On pages 62 and 63 you have given some attention to the subject of parallel-depth bevel gears. Perhaps the history of this style of bevel gears will be of interest. In 1872, being with the Blees Sewing Machine Company, located on Bridge street, Brooklyn, I made the first of these gears. We had gears to make in a hurry and no bevel-wheel cutters suitable for them. In this crisis two wheels were turned to a drawing made by a young draftsman who innocently drew their faces parallel to the pitch cones. These were given me to be cut.

Then it was found that the blanks were wrong and another pair was ordered from a corrected drawing. Overnight I conceived the idea of cutting these gears as they were turned; parallel to the pitch cone. In the morning they were measured up and it was found that the inner diameters corresponded to 12 pitch and gave the ratio of teeth required—2 to 3, if I remember right. Then came the inspiration to use regular 12-pitch spur-wheel cutters. On this plan the gears were cut and gave surprisingly good satisfaction. The flanks of the teeth rubbed everywhere from one end to the other; from the tops of the teeth to below the pitch line.

Afterward, for nine years, I was not in the manufacturing end of business, but in 1881, at Elizabethport, I had made for me a number of these gears and have continued to make them ever since.

In 1891, in a conversation with Mr. Hemminway, then an editor on the AMERICAN MACHINIST, I mentioned these gears to him and at his desire I wrote an article of considerable length fully describing their features and the method of cutting them with spur-wheel cutters. This article was considered by him to be too long for its importance, and it was cut to a bare outline of the principle involved. It is my recollection that I wrote the short article in the AMERICAN MACHINIST office on Fulton street, and with a pencil. There was a rough sketch, a section of the gears, made at the same time, I believe. In that, or similar shape, the article was printed.

Shortly afterward Walter Gribben became interested in this method of cutting gears, and gave it considerable attention; always kindly giving credit to the original source of information. His formulas for manipulating the dividing head I have since used to advantage.

West Lynn, Mass. A. D. PENTZ.

Rubber Stamps in Drawing Room

On page 84 of Drawing Room Kinks, the use of rubber stamps is suggested but I find that considerable practice is necessary before one can produce good clear-cut letters, as common pad ink does not always adhere to the tracing cloth.

I have found it more satisfactory to use opaque ink. The regular commercial article known as "Excelsior Opaque Quick Drying Ink," will print up the same as drawing ink.

Using a set of type and a holder with this ink enables one to get out special titles, etc., at a very low cost.

On any class of work where the same outline is frequently used, it will pay to have a stamp made up and used instead of tracing from a standard. An example of this is in switchboard work where ammeters, switches, circuit breakers, etc., are used many times. The General Electric Company, Schenectady, made up a complete outfit of such stamp outlines which are in charge of a clerk. The draftsman simply locates the center lines for the various instruments, then notifies the clerk, telling what particular instruments are wanted and the clerk stamps them on the tracing. The saving in time is evident.

Some companies now use a form for a title which is stamped on as needed by using opaque ink. The line cut shows a form used where each part is on a separate sheet (a practice rapidly growing), the stamp in constant use is only cleaned about once a month. It gives a uniform appearance to all the drawings and insures the entering of required information.

A title applied in this way would, I believe, appease Entropy (page 110) as it bears the same relation to the drawing as does a suit of overalls to a workman, that is, looks like business. Entropy compared a title to collars and cuffs.

Where the number of drawings is very large, tracing cloth is now cut to size and the title printed on at a printing office, the printer, of course, using an opaque ink as the regular printing ink rubs off easily from tracing cloth.

Rochester, N. Y. RALPH W. DAVIS.

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The Shop Instructor

There is, we believe, more behind the institution of the shop teacher of apprentices than a mere detail of shop management, as it is, we believe, in a very large way an adaptation of modern industrial conditions to the apprentice problem, and to a considerable extent a reversion to old practices so far as that can be done under new conditions.

We have often been told of the old conditions under which the apprentice worked with his "master" and received direct instruction through personal contact, and how all this has disappeared under the prevailing conditions in which the "master" is that intangible thing, a corporation, with whom the old personal contact is impossible.

Under the prevailing conditions the man who represents the old employer, so far as his authority over the apprentice is concerned, is the foreman, who, however, differs from the old employer in that he does not personally do the work of production, but supervises and directs the work of others. In other words, the foreman while representing the authority of the employer cannot represent him as a teacher, the teaching function of the old employer being practically absent from modern apprenticeship under prevailing conditions.

The apprentice teacher is not a new institution, but he has been brought into renewed prominence and importance by Mr. Alexander, at the Lynn works of the General Electric Company, where, as it appears to us, he is simply the representative of the old employer in his teaching capacity. The development of the factory system having made it impossible for any one man to represent the old employer, both in his teaching and directing functions, it has become necessary to install a special man to represent the missing function, as one has already been installed to represent the directing function.

Looked at it this way, it will be seen that there is a large philosophy behind Mr. Alexander's plan and the fact that, after all, it is but a continuation of old methods under new conditions gives one an added feeling that it is, at bottom, sound. We, today, scarcely realize how the teaching function of the old employer has disappeared under modern conditions, and that it is to this that we must charge the comparative failure of modern apprenticeship. If apprenticeship is to again become successful, it is clear that this teaching function must be revived, and we believe that under Mr. Alexander's plan the results will be even better than they were under the old system. Not many men are teachers, and this was as true of the old employers as it is of modern foremen. The old employer's success in business depended on something very different from this, his work as a teacher being purely incidental and the character of a teacher which any one boy obtained being purely a matter of accident. With the new system the teaching is not an incident to other work. The teacher is selected for that work alone, and in teaching ability he ought to average far better than the old employer did or could. Here and there in every shop will be found men who are natural teachers and who delight in imparting instruction to others. It is such men who will naturally gravitate to the teacher's position under the new system, all of the boys in the shop being favored with the help of an expert instead of a casual teacher as of old.

The more the shop teacher is studied the more his possibilities develop. He, more than any other thing that has been suggested in all this discussion, represents a real revival of the spirit of the old system of apprenticeship and promises to rescue that time-honored institution from the decay into which it has fallen.

The Reorganization of the Navy Yards

Our readers have no doubt seen in the daily papers the news item relative to the order of the Secretary of the Navy by which the management of the navy yards is to be entirely reorganized and revolutionized.

Those who have been familiar with the facts are aware that the system of administration which has until now prevailed in our navy yards has been one which would not be tolerated for a moment in any manufacturing establishment, the yards having been administered under a system of independent departments and divided responsibility which has made effective supervision and direction impossible and resulted in a deplorable state of inefficiency.

For the first time in many years the Secretary of the Navy is a practical manufacturer, and he has lent a willing and intelligent ear to the protests of those who would see the old conditions changed, the result being this order which in a few words has altered the entire situation, so far as an order can do it, and prepared the way for reorganization on lines which cannot fail to have the most beneficial and far-reaching results.

Our naval constructors are given an elaborate preparation for administrative duties. They first graduate from the Naval Academy, go to sea two or three years, and then the best men in the class are picked for assignment to the construction corps. After this they are given a three years' course of study in the best schools in naval architecture and engineering in the world. Until a few years ago they were educated in Glasgow, the Royal Naval College at Greenwich, and

in Paris. At the present time a special course of study has been arranged at the Massachusetts Institute of Technology, and they are given a splendid course there.

Under the old system all this accomplished but little as the heads of the various departments were line officers with no knowledge of the conduct of industrial establishments, and among whom there was little or no coöperation, while the naval constructors had too little authority to make it possible for them to do effective work, and the conditions by which they were surrounded were so discouraging as to lead to frequent resignations prior to entering civil life.

Hereafter, in place of this system of divided responsibility the entire industrial establishment of each yard is to be consolidated in one department under the naval constructor who, as general manager, will report and be responsible to the commandant-in-charge of his yard. The general manager will hereafter have charge of the entire plant, the heretofore independent heads of existing departments becoming subordinate and responsible to him.

The constructors will now have an opportunity. Industrial work and engineering becomes their life work, with responsibility and a career before them, and it is believed that resignations will largely stop.

The Panama Canal

Every American citizen should read an editorial in the current issue of the *Engineering News* on "The Reasons Why the Lock Plan for the Panama Canal is Preferable to the Sea Level Plan." This editorial was written by the editor-in-chief of the paper after visiting the canal in company with President-elect Taft and his party of engineers, and of all that has been written on the subject, it is the most striking, concise and conclusive article that we have seen.

The article takes up every important phase of the controversy in a way that is understandable by every reader, and while we can do little more than call attention to it, we may, nevertheless, say that it does not advocate the lock canal as a cheaper or more expeditious one to build, but as one which is absolutely better and safer than the sea-level canal. A fundamental feature of the sea-level canal is a 25-mile stretch through the swamps and along the course of the lower Chágres river, the bottom of the ditch being at the extreme point, 90 feet below the bottom of the river. The digging of such a ditch through such ground has never been done and how it is to be done and how it is to be maintained after it is done, no one knows, while the constant danger from the tropical floods of the river is an element of the first magnitude.

Regarding the danger of damage to the locks from earthquakes, it is pointed out that this danger is quite as imminent with the sea-level plan as with the lock plan. The sea-level plan involves an enormous masonry dam, over 200 feet high for the control of the Chágres river and this dam is obviously just as vulnerable to earthquakes as the masonry constructions of the lock canal while the result of its failure from earthquakes would be at least as serious.

These few sentences will illustrate the manner in which the subject is discussed. The objections to the lock canal are taken up point by point and as between this article and the irresponsible fulminations of the daily press, there can be no question of the one which should command the confidence of the American public. The editorial deserves the most widespread publicity, which we hope means may be taken to give it.

Carroll D. Wright

Carroll D. Wright, president of Clark College, and a national figure in the world of education, in all its phases, died at his home in Worcester, Mass., February 20.

Mr. Wright came from New England stock and was born in Dunbarton, N. H., in 1840. His early education was ordinary, and after trying several vocations he settled down to the practice of the law. Early in the seventies he entered politics and at once won distinction as an exceptional statistician, and when the important Federal office of United States Commissioner of Labor was created he was appointed to fill the place. His services in that capacity won him a national reputation and in 1905 he accepted an urgent call to become the first president of Clark College. Since that time Mr. Wright had given considerable thought to industrial education, and wrote many valuable articles, as well as delivered many important lectures in connection with the subject. He was actively interested in the work of the National Society for the Promotion of Industrial Education and had served as its president.

Lewis J. Atwood

Lewis J. Atwood, a prominent figure for many years in manufacturing circles of Waterbury, Conn., died at his home in that town, having passed his 81st year.

He took up life in Waterbury about 64 years ago, and when but a young lad showed signs of exceptional mechanical ability. His first business venture was in the manufacture of buckles and buttons, but from lack of capital it was discontinued. Then followed another venture in brass goods manufacturing, subsequently becoming associated with the firm of Holmes, Booth & Haydens. He soon became a member of the firm and its name was later changed to Plume & Atwood Manufacturing Company. In 1890 he became president of the concern, which office he held at the time of his death.

As an inventor Mr. Atwood developed many inprovements in the manufacturing processes of his shop, notable among which was a hydraulic press used for scrap metal preparatory to remelting, which machine was widely adopted.

Personals*

Alex. T. Drysdale, for some time general manager of the Sheffield Cast Iron Pipe and Foundry Company, has recently resigned his position.

J. A. Bennett, of Hartford, Conn., has accepted a position as mechanical engineer with the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.

P. A. McCabe has severed his connection with J. J. McCabe and become connected with the McCabe Machine Company, of 95 Liberty street, this city.

P. A. Schmitz, representing Walzmaschinenfabrik August Schmitz, Düsseldorf, Germany, is spending a few weeks traveling in this country on business.

Harold C. White, chief draftsman of the General Railway Signal Company, Rochester, N. Y., has resigned, and is now considering a commercial proposition.

Edward C. Halblieb, signal engineer, with the General Railway Signal Company, has recently joined the engineering staff of a Cleveland firm manufacturing heating devices.

William E. Moore, formerly manager of the Auburn Ball Bearing Company, Rochester, N. Y., recently resigned to accept an executive position with the Rochester Germicide Company.

Garret Reekers, formerly factory foreman in charge of the electrical department of the General Railway Signal Company, Rochester, N. Y., has gone into the manufacture of coils and electrical winding of all varieties.

Virgil M. Palmer has recently accepted a position as engineer with the Selden Motor Vehicle Company, Rochester, N. Y. Mr. Palmer was formerly connected with the Smith Automobile Company, of Topeka, Kans.

Frederick W. Taylor, past-president of the American Society of Mechanical Engineers, delivered an interesting address along general engineering lines before the College of Engineering of the University of Illinois on February 18.

The personnel of the newly organized Cincinnati-Bickford Tool Company is announced as follows: August H. Tuechter, president; Sherman C. Shauer, vice-president and general manager; W. H. Schafer, secretary; George P. Gradolf, treasurer and H. M. Norris, engineer.

*Items for this column are solicited.

Edwin Reynolds Dies After a Long Illness

Contemporary of Corliss and Superintendent of the Corliss and Allis-Chalmers Shops Passes Away at Milwaukee; Sketch of His Career

Edwin Reynolds died at his home in Milwaukee on Friday, February 19, after a three-years' illness.

Edwin Reynolds was born March 23, 1831, at Mansfield, a little town in northeastern Connecticut. He was descended from William Reynolds, who had come from England about 200 years before and settled at Providence, R. I. His father's name was Christopher Reynolds and his mother's maiden name had been Clarissa Huntington. There was a large family, six boys and six girls, and Edwin was next to the youngest. His father, though then a farmer, had been a cloth dresser and had on his place a fulling mill run by water power, but this had not been in operation within the boy's recollection. Edwin worked on the farm and went to the district school, his last schooling being in his sixteenth year, and then a change came in his life. He had up to this time little or no knowledge of the machine shop, and nothing had turned his thoughts or inclinations in that direction. At the age of 16, Mr. Reynolds started out as a farm hand, engaging first with a neighbor for six months at $11 per month. He had worked only about a month when one day, as he was busy in the middle of a field, a man climbed over the fence and came to him. The man asked first if he was one of the Reynolds boys, and then whether he would like to learn the machinist trade. It was a new idea to him, and he had to think over it for a little while before he said that he would, but he immediately added that it would not be possible to begin just then, as he was engaged to this farmer for six months. The farmer was a reasonable man. On being consulted he said:

"Would you like to learn the trade, Ed?"

"I think I would," said Mr. Reynolds.

"Well, a trade is a mighty good thing to fall back on. I'll tell you what I'll do. You come and help me for a month in July and I'll let you off now."

So a three years' apprenticeship was begun with Anson P. Kinney, or Kenney, who had a general machine shop, with a specialty of sewing-silk machinery; several cards, or carding machines, also being built during Mr. Reynolds' apprenticeship. A country shop in 1847, we can well understand, was a crude affair. There was in the first place no foundry. The tools of the shop comprised one 20-inch engine lathe, one bench lathe, or, as we might now call it, a patternmaker's lathe, one vise and a circular saw. Some creditable machines were, however, turned out, and Mr. Reynolds' apprenticeship consisted largely in learning, not the trade as we understand it, but "how to do things without any appliances wherewith to do them." A memorable event of Mr. Reynolds' apprenticeship was the addition of a 16-inch lathe to the plant. Mr. Reynolds lived with his employer and their relations were more like father and son. His wages were, for the first year, $30 and his board, the next year $45 and for the last year $60.

On the completion of his apprenticeship Mr. Reynolds worked as a journeyman for a year with Smith, Winchester & Co., at South Windham, Conn., who built paper machinery, and then he went as a journeyman to the Woodruff & Beach Iron Works, at Hartford, one of the large companies at that time, which built slide-valve steam engines and general machinery. While Mr. Reynolds was working there, Mr. Wright became engineer of the works, and they began the building of the Wright engine. No concern in those days, however, built engines exclusively, and the Woodruff & Beach works, among other things, turned out a lot of stone-dressing machinery, in the building of which Mr. Reynolds soon became a gang boss, eventually taking charge of all that line of work in the shop and in the erection of the machines after they were sent out. This connection continued for six or seven years, or until about 1857, when Mr. Stedman, of Stedman & Co., Aurora, Ind., who had been a classmate of Woodruff, came East looking for a superintendent, and Mr. Woodruff—as some other employers have nobly done, but as some would not have done—recommended his subordinate as precisely the man for the position and so Mr. Reynolds went to Aurora as general superintendent. The silent partner of Stedman & Co. was a resident of Aurora—J. W. Gaff, a wealthy distiller and steamboat owner—and, with Grey and Gordon, the owner also of the Niles Tool Works. Stedman & Co. had a general machine-shop business, building also plain slide-valve engines, sawmills, farm machinery and pumps for Southern plantations. The designing of large pumps for drainage and irrigation was a promising field which

EDWIN REYNOLDS

Mr. Reynolds proceeded to develop. Patents of the old Andrews pump and others were offered the firm, but none showed or promised satisfactory efficiency, so Mr. Reynolds decided to design a pump, and in connection with this scheme he made some crude experiments, the results of which have been of value to him in connection with his largest and most daring work of later years.

The breaking out of the war between the States interfered so seriously with the business at Aurora that Mr. Reynolds found himself out of employment and came East, making Boston, New York and other places his quarters for the next few years. These were no more years of idleness than the others had been. He took charge of a shop in Boston for George T. McLaughlin, and besides that he was interested in the development of a number of special machines, either as designer or consulting engineer.

In 1867, Mr. Reynolds, who had become known as a manager combining technical knowledge with executive ability—then, as now, a rarity—was offered a commercial and engineering position with the Corliss Steam Engine Company, whose shops at Providence, R. I., were the largest and most important in the country, if not in the world, for the manufacture of steam engines. The Corliss plan of operations had from the first and always called for salesmen who distinctly were competent engineers. After four and a half years in this position, Mr. Reynolds was made general superintendent of the works, which position he held until 1877. He had not held the position so long without suggestions and invitations to change. His old friend, Mr. Gaff, and also Mr. Gordon, of the Niles Tool Works, tried hard to get him to take hold of that institution, offering an interest in the works or terms exceedingly favorable. Having declined this offer, the acceptance of a connection with the Reliance Works of E. P. Allis & Co., Milwaukee, Wis., may have a rather unaccountable aspect. The position held by Mr. Reynolds at Providence was then perhaps the highest in the engineering business in the United States. He went to the remotest corner of the manufacturing field, and connected himself with a firm practically unknown and in embarrassed circumstances. The firm had failed the year before; they had a ramshackle shop; the foundry, which had been fitted up for pipework, was of a piece with the rest; and, all told, only about 150 men were employed. It is scarcely probable that Mr. Reynolds foresaw what the business would so soon grow to, but he must have seen in it more or less clearly the opportunity of his life. Mr. Corliss had grown rich and dictatorial, seemed to believe that his word was law in steam engineering, and took the position, more or less pronounced, that any man who wanted the best engine must buy it of Corliss and must pay the Corliss price for it without question. In the meantime, Mr. Reynolds, as events would seem to indicate, had ideas of his own about Corliss engines and other things. He evidently believed that the original Corliss engines could be greatly simplified and improved, and that he knew the way, and that the improvements, combined with correct business methods, must result in the building up of a great business. There may have been more than a little of sympathetic benevolence in it, also. Here was a concern in a bad way. Neither Mr. Allis nor his sons had engineering knowledge or ability. He could help them, assume an independent position for himself and find full employment for his teeming engineering ideas, and so he became the engineering brains of the Allis works.

It has been erroneously stated, on many occasions, that the attention of Mr. Allis was particularly attracted to Edwin Reynolds by the "Reynolds-Corliss compound engine" exhibited at the Centennial in 1876. As a matter of fact, however, this unit consisted of two simple Corliss engines compounded, and they were of the regular type built at the Providence shops. Further than for his being general superintendent of the works at the time, there is no reason particularly to identify Mr. Reynolds' name with that of the Centennial engine.

After entering upon his duties for Mr. Allis, the first and most essential thing was to place the business on a paying basis. This was done almost at once through the development of the "Reynolds-Corliss" engine, which has become a synonym for simplicity, economy and reliability, collectively expressed. The first engine was a 14x36-inch girder-frame Corliss stationary engine. It was sketched on the back of an envelop during a ride from Milwaukee to Chicago, after his first visit to the scene of what were to be his life's greatest successes. This design was not his best on general principles, but the best to build with the shop equipment at the time. This, it will be understood, was not only miserable, but there were no means at hand for the purchase of better. The first tool put into the shop after Mr. Reynolds took charge was an 8-foot boring mill, furnished by Mr. Reynolds' old friend, Mr. Gaff of the Niles Tool Works. Mr. Reynolds had to and did design the thing which it was possible to build in the shops as they stood, without spending a cent at first for equipment. It was necessary to compromise, not only with the machine shop, but more especially with the foundry, which was worse, and even the facilities, worst of all, for transporting the castings from the foundry to the machine shop had to be yielded to. The frame, then, was made in two parts, so it could be handled, so either right or left could be made from the same pattern, and so, in deference to the lack of skill in the foundry, the core work was reduced to a single simple core in the jaw. At a later time, when the demands of the business were growing faster than the facilities, the wrought-iron-frame engine was designed as a means of relief. The Reynolds engine of 1890 may probably be said to be the first design in which serious concessions have not been made to the facilities of construction or other imperative conditions. Mr. Reynolds' method of work has seemed to be first to make a careful study of all the conditions of the individual case, and first of all with reference to the underlying engineering principles. On these for a foundation he would work out the simplest machine possible, remembering always the possibilities of the shop as well as the idealities of the drafting room. This has usually practically ended the matter. Once the design has been decided upon, he has been prepared to fight for it, and usually successfully, and a very large part of the Allis business has been obtained, not so much by underbidding in price as by embodying the best engineering features.

It would be difficult to overstate the character and importance of the work that Mr. Reynolds accomplished during his unostentatious life. In brief, he was the foremost practical man, the responsible technical manager, in an engine-building establishment which, under his guidance, grew to occupy a position in the very front rank of reputation, and in point of magnitude to surpass all others in the United States. The machinery built by it has been of varied nature; it has included many large Corliss-engine units for pumping service, mining, air compressing, furnace blast, street-railway work and other purposes. In the name of the "Reynolds-Corliss" type of engine, this engineer received one of the deserved marks of recognition which raised him out of anonymity in his business relations with the public.

To him especially is attributed the use of compound and triple-expansion engines in manufacturing plants, one of the first large ones employed for that purpose being installed by him in the Eagle Mills, at Milwaukee, in 1878. He was the first to build the low-speed direct-connected type of engine for driving a generator.

Among achievements of his life, long before the close, was the construction, in 1888, of the first triple-expansion pumping engine built for waterworks service, which he installed at Milwaukee, to run under a pressure limited to 80 pounds. The steam consumption proved as low as 13.84 pounds per indicated horsepower per hour. Some time later, two engines installed in the West Harrison street station, Chicago, showed a steam consumption of 12.67 pounds, which was believed to break the existing economy record. An engine built for Omaha, with 40-, 70- and 104-inch diameter steam cylinders had a

capacity of 18,000,000 gallons in 24 hours, raised 310 feet. A 30,000,000-gallon triple-expansion pumping engine was built for the Boston waterworks, its installation being completed in December, 1898. It made the world's record for efficiency and economy of operation, its average consumption of dry steam per indicated horsepower per hour being 10.335 pounds, and its duty per 1000 pounds of dry steam, 178,497,000 foot-pounds. A 15,000,000-gallon triple-expansion pumping engine for the St. Louis works, also built by the Allis company, proved a close second, showing an average dry-steam consumption of 10.676 pounds and duty of 179,454,255 foot-pounds.

When constructing an engine for flushing the Milwaukee river with Lake Michigan water, Mr. Reynolds designed a propeller-type pump, which was built against strong opposition, but the performance of which amply vindicated his judgment. The efficiency of the wheel was 86.75 per cent. The large centrifugal units for sewage plants, each driven by vertical shaft from a horizontal triple-expansion engine, with piston rods 120 degrees apart, originated in his fertile brain. The centrifugals were originally designed to handle Boston sewage.

Another product of his skill is the Reynolds ore stamp, in which he substituted a solid cast-iron foundation for the wooden spring bottom that formerly had been deemed necessary. The result was nearly 50 per cent. increase of output. This invention added much to the value of the great copper properties.

When he built his blowing engine for the steel works at Joilet, Ill., he stirred up the experts. Although his design marked a radical departure from previous types, its valuable features were recognized at once and received the contract. Andrew Carnegie ordered one like it before it had been running a month, this being the beginning of work for the same company that many years ago had amounted to $5,000,000.

Among other works of Mr. Reynolds was the combined horizontal and vertical reversing engine built for the American Steel and Wire Company, at Worcester. The cylinders of this engine were both high-pressure, 44x60 inches, the construction leaving one end of the shaft free for direct connection to the rolls and doing away with the gears, which have always been an objectionable feature.

An instance of the marvelously quick inventive genius of Mr. Reynolds was afforded when he designed the engines for the Manhattan elevated railroad, of New York. A staggering problem of getting a maximum of 12,000 horsepower in limited space and without undue weight on the bearings seems to have been very simply solved, and the weight of the flywheel was reduced one-half. This engine may be taken as illustrative of the building up of the Allis business by Mr. Reynolds. The contract was secured because as an engineering proposition the design submitted was so superior to others offered in competition that the price was a secondary consideration. As a sample of the confidence in Mr. Reynolds' judgment and skill, $3,000,000 worth of this type of engine were ordered in a lump before one of them had been built and erected. Regarding the circumstances attending the design of the Manhattan engines, the following anecdote is related:

"The Allis-Chalmers Company, having built eleven 3500-kilowatt standard cross-compound, vertical, direct-connected engines for the Metropolitan Railway Company, was called upon for advice as to the type of engines to be used in the immense new power house then being planned by the Manhattan Railway Company, in New York City. It was the intention of their engineers to install units of 5000 kilowatts capacity. The first type of engine considered was the cross-compound, vertical machine, similar to those furnished for the Metropolitan Railway Company, and some correspondence passed between Mr. Reynolds and the engineers of the Manhattan Railway Company on the subject, so that finally Mr. Reynolds was invited to visit New York and discuss the matter in detail. Mr. Reynolds left Milwaukee with the question of the type of engine still unsettled, but with the understanding that the straight, cross-compound, vertical unit would be used if it were found practicable. Mr. Reynolds was traveling from Albany to New York when the question demanded his attention, and he was informed by telegram that a committee representing the owners of the elevated road would meet him at the Grand Central station. During the ride down along the Hudson he thought the matter over; then, as the train reached the Harlem, he hastily sketched on the back of a letter the substance of the plan ultimately adopted, including the practically unique design of the horizontal-vertical, four-cylinder compound engine, with cylinder sizes and approximate dimensions of all other principal parts, such as crank pins, crosshead pins and main journals. When the work came to be laid out on the board, there was very little variation from his original figures.

Mr. Reynolds' ability was not evidenced by his engineering successes exclusively. He was also the man of business. It was by the combination of engineer and business man and all-round manager that the enterprise with which he was associated has so marvelously grown. He was held in the highest esteem by Mr. Allis. In the will of the latter, who died about the beginning of the nineties, he was named as one of the trustees of the Allis estate. Upon the reorganization of the business, which followed, he was elected director and second vice-president of the E. P. Allis Company.

In 1901, the Allis-Chalmers Company, with $50,000,000 capitalization authorized, was formed to consolidate the E. P. Allis Company, Fraser & Chalmers, Gates Iron Works and Dickson Manufacturing Company. In the organization Mr. Reynolds played a prominent part, being a director and the chief engineer of the new corporation. This gave him the opportunity of laying out at West Allis, a suburb of Milwaukee, the great engineering and machinery-building works which constitute one of his proudest monuments. It is so constructed that it never can be what was Mr. Reynolds' principal aversion, an "accretion"—the adding on of one building or leanto after another, without proper sequence. Instead, it is built throughout on the unit system; the structures of general utility being capable of indefinite extension toward the rear, with space for the corresponding machine shops to lie at right angles between them.

In the fall of 1905, Mr. Reynolds retired from active service, with the title of consulting engineer, and, although in feeble health, he maintained a happy, helpful existence at his beautiful residence on the hights overlooking Lake Michigan, loved and honored by all his associates.

Mr. Reynolds was interested in various business undertakings outside of the Allis company, being president of the Daisy Roller Mills, Milwaukee Boiler Company, German-American Bank and Morning Mining Company.

The University of Wisconsin conferred upon him the degree of LL.D., and later placed his name upon the frieze of the new engineering building. He has received honors from institutions of learning throughout the civilized world. His election to the presidency of the American Society of Mechanical Engineers for 1901-1902 was a recognition of his eminence in the profession, which the society honored itself by conferring. He was received into active or honorary membership of the leading engineering societies at home and abroad, and he became the first president of the National Metal Trades Association.

The influence of Edwin Reynolds remains expressed not only in mechanical types, but in human personalities. To be a brilliant designing engineer, particularly in the field of power generation and application, is a matter of self-gratulation to anyone so gifted, and is a benefit to many affected by his work; but to lead the way so plainly that others may follow with no uncertain step, to train a large number of young assistants so that they become efficient, original co-workers and themselves the chief officers of engineering works, and to found, develop and leave in sound condition a great manufacturing establishment—such is the province of a master mind, one of the few which a century produces.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

The Bullard Supplementary Turret

This is a new device recently brought out by the Bullard Machine Tool Company, Bridgeport, Conn., to facilitate the handling of the tools used on their vertical boring mills. It consists of a substantial turret tool holder in place of the regular tool head and fits in the tool slide in place of it.

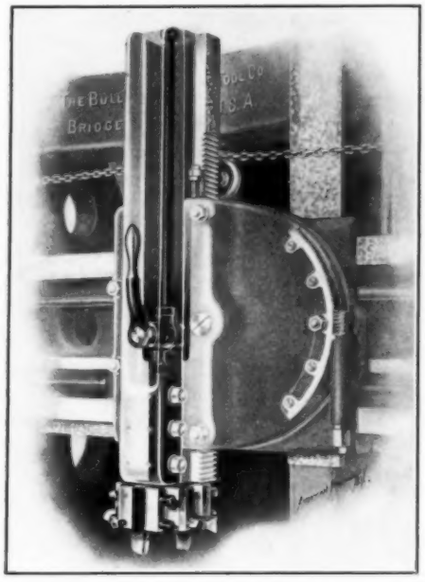


FIG. 1. THE BULLARD SUPPLEMENTARY TURRET

The method of holding is shown in Fig. 1, the lever drawing the tool head solidly up against the slide by means of an eccentric and locking it in its correct position by a long contact between bevel shoulders on both the tool head and slide, at the back. The locking of the cam is adjusted by the long bolt at the top so as to always insure the supplementary turret being properly locked.

The advantages of this method over the setting of single tools for each operation or even two tools, can be readily imagined, but must be seen to be fully appreciated. After a roughing cut is taken, the handle is loosened, the turret turned to bring the finishing tool into place, the turret locked, the head adjusted, and the next cut is taken. Without taking out a tool, the boring and facing tools are brought into position one after the other and the time saved is more than might be imagined unless it is realized that in many cases the setting of tools takes a third of the total time of manufacture.

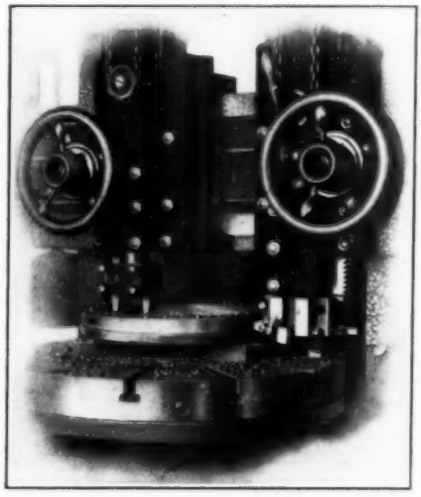


FIG. 2. TWO AND FOUR TOOLS IN USE

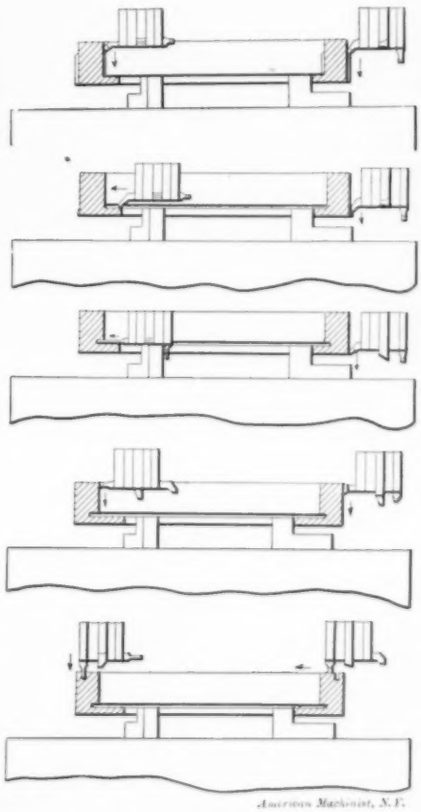


FIG. 5. USING EIGHT TOOLS IN TWO TURRETS

Fig. 2 shows the contrast between the two- and four-tool methods, the latter carrying all the tools needed to finish the piece of work, and the other requiring a change of tools, or the use of another head. Fig. 3 shows one slide with a supplementary turret and the other with a boring bar, but fitted for a turret, as shown by the hole for the locking eccentric above. The other head is finishing the disk, the head being set at a slight angle to bring the tool not at work, clear of the surface, yet have it swing into its proper position when the turret is turned. With both heads fitted with the supplementary turret, eight tools can be always in readiness for the various cuts, as shown in Fig. 4.

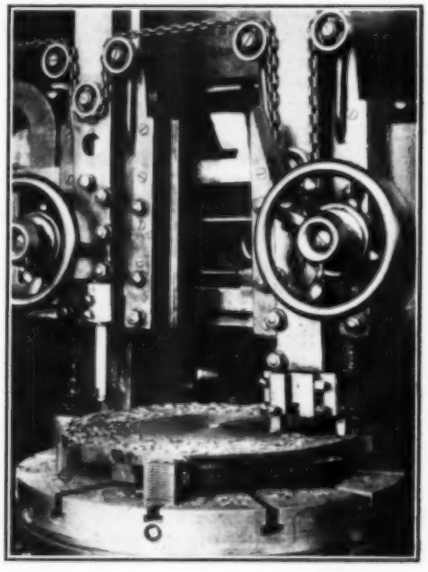


FIG. 3. TOOL HEAD SET AT AN ANGLE FOR CLEARANCE

Fig. 5 shows outline diagrams of the

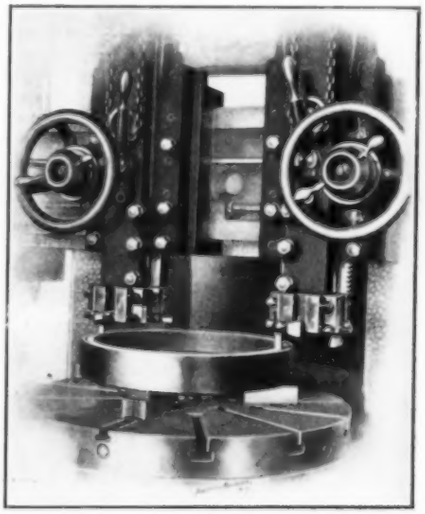


FIG. 4. TWO TURRETS IN USE

use of the eight tools shown in Fig. 4, and makes clear the advantage of being able to use a number of tools without resetting. It also shows a tool layout, as supplied to users or prospective users, giving them a suggestion as to the best way of accomplishing the work in hand.

Another good feature of this supplementary turret is that it can be applied to boring mills already in use and does not interfere with the use of the mill in the regular way or with any other tool desired.

A New Construction of Micrometers and Other Tools

The line of tools illustrated herewith shows a wide variety of applications of the same principle, namely, the use of a stationary screw with an internal spindle, which is moved by a cross-bar or pin acted on by a groove inside the nut.

Beginning with the micrometer, Fig. 1, we find the screw on the outside of the barrel, surrounded by the nut having an internal groove, which moves the spindle in and out by a pin through the back end working in and kept from revolving by the slot in the barrel. Means not shown, are provided for taking up any wear in the nut or screw.

This arrangement gives a micrometer in which neither measuring point turns and so avoids the tendency to roll or twist the piece being measured, which at times interferes with the accuracy of the touch or feeling and consequently the reading. The spindle is graduated all the way round and the mark nearest the frame shows, in tenths of an inch, the amount it is open, while the thousandths are read from the edge of the nut and the mark on the grinding pin or key. A telescoping thimble or sleeve can be provided to protect its threads on the screw when desired, although the nut keeps it out of contact with the bench or machine when laid down.

FIG. 1. A NEW MICROMETER CONSTRUCTION

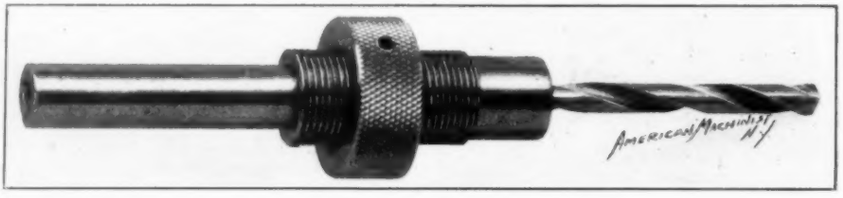


FIG. 2. A SMALL ADJUSTING DRILL SOCKET

As a Drill Socket and Spindle

The use of this principle in drill and milling-cutter sockets is for securing a positive adjustment of the drill or mill with relation to the work, without moving the table. It is particularly valuable in multiple drill work for securing proper adjustment for depth of the various drills and in profiling machines this is much easier than adjusting the table and work. Fig. 2 shows this for a small, straight shank drill driven by a pin through the shank and working in the slot and nut.

As shown in Fig. 3, the outside of the

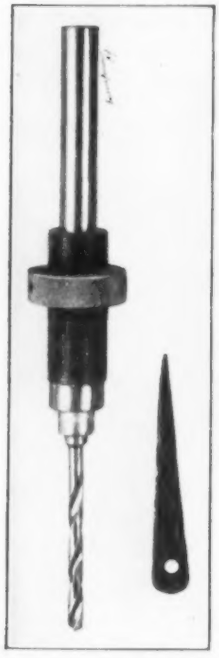


FIG. 3. FOR A DRILL SPINDLE

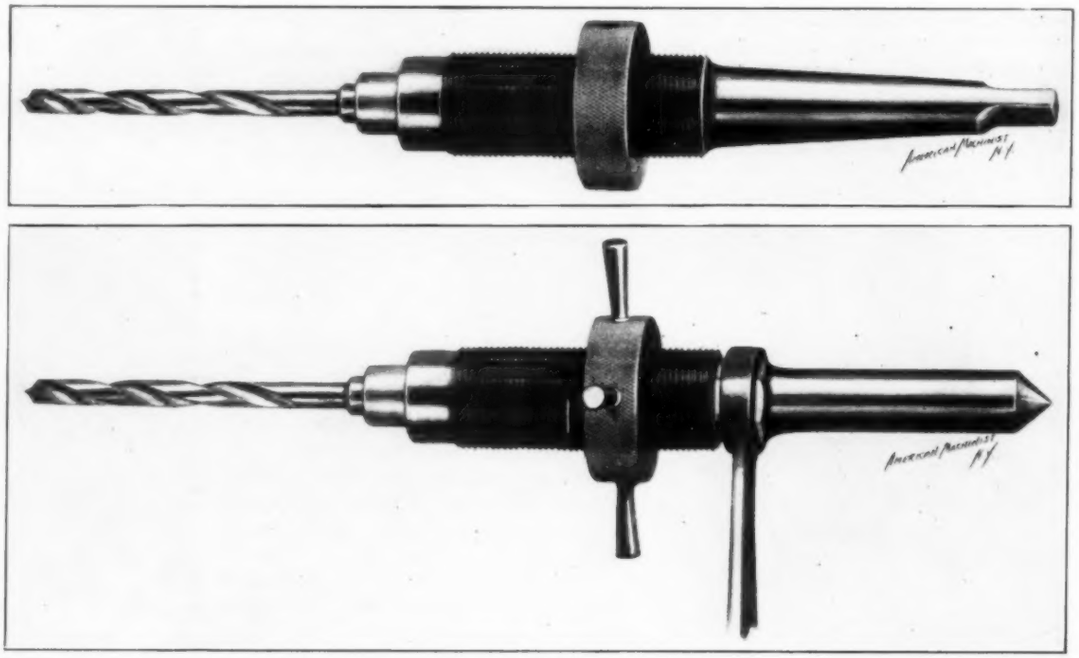


FIG. 4. AS AN ADJUSTABLE SOCKET WITH TAPER SHANK

FIG. 5. AS A RATCHET DRILL

drill spindle is threaded to receive the nurled nut, and the inner collet is moved by it. This collet holds the regular taper-shank drill in the usual way, driving by the tang and having the usual key for removing the drills. This is also used as in

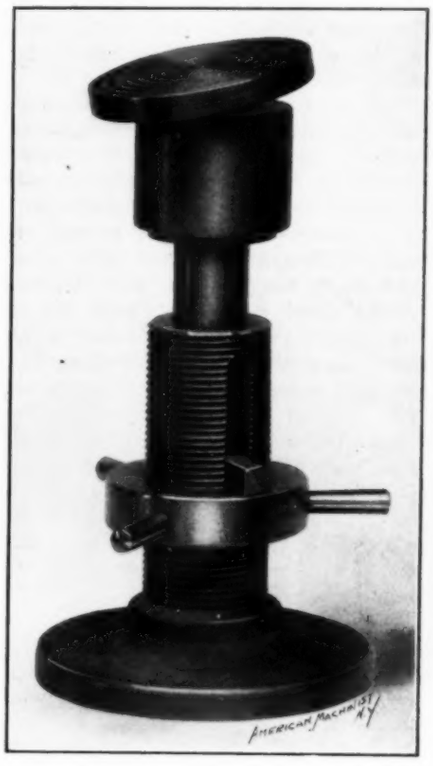


FIG. 6. AS A SCREW JACK

Fig. 4, a drill or milling-cutter socket having a taper shank for the driving spindle of the machine. The inner collet is adjustable, thus securing the same effect as before.

As a Ratchet Wrench

Another application along a different line is shown in Fig. 5, where the construction is very similar except for the hexagon milled on the shank and the four small handles inserted in the nut. This used in connection with a standard ratchet wrench, makes a very convenient ratchet drill as can readily be seen.

Still another aplication of the same principle is seen in Fig. 6, which shows a planer jack, but can be equally well applied to a screw jack of larger size.

This does away with all tendency to twist out from under the work when being adjusted, which is not entirely obviated by the use of the loose cap owing to the great friction under load. These are the inventions of Frank E. Bocorcelski, superintendent of the Baush Machine Tool Company, Springfield, Mass.

Horizontal Rotary Planing Machines

A cutter drive which is somewhat out of the ordinary is shown in Fig. 1, which is one of a number of Newton horizontal rotary planing machines fitted with chucks for the rapid production of turbine segments in operation in the works of the General Electric Company. The later design, as recently furnished, is illustrated by Fig. 2, the drive being applied direct to the cutter head and the cross-rail has vertical adjustment. The cast-steel face plate or cutter head is 30 inches in diameter over the cutter tools, and is driven by an internal gear by vertical worm shaft, shown at left of cutter spindle. Motion to this worm shaft is transmitted through intermediate gearing from the 10-horse-

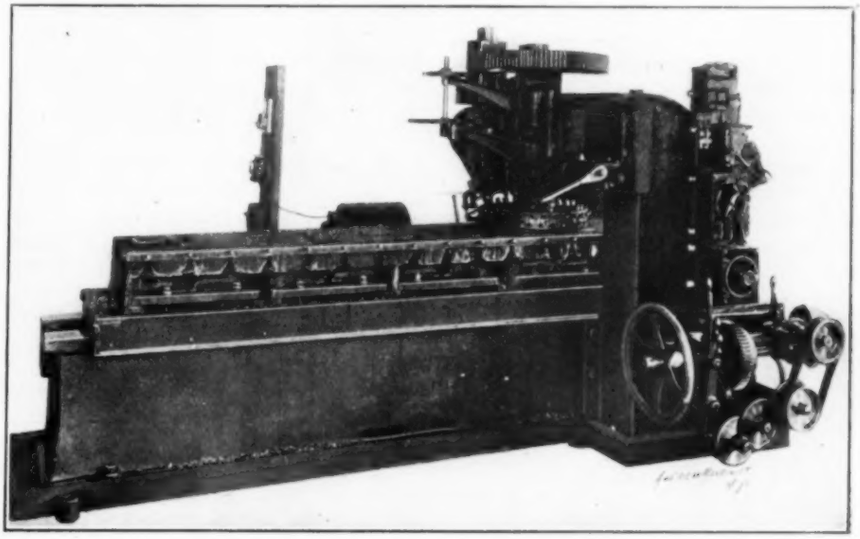


FIG. 1. FITTED WITH RADIAL MILLING ATTACHMENT FOR TURBINE WORK

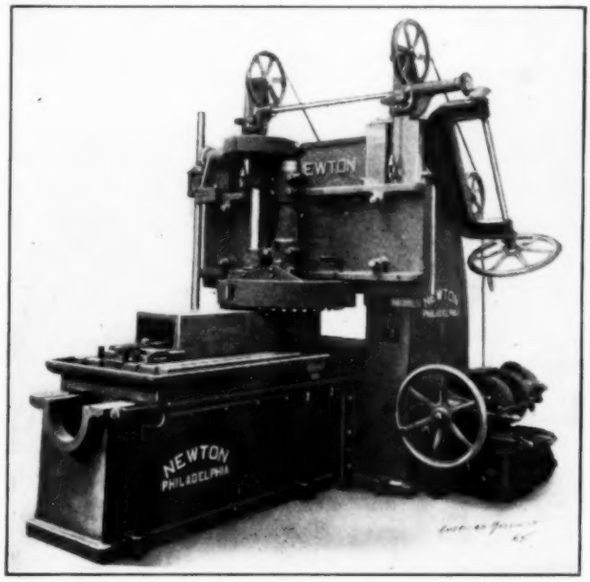


FIG. 2. INTERNAL GEAR-DRIVEN CUTTER HEAD

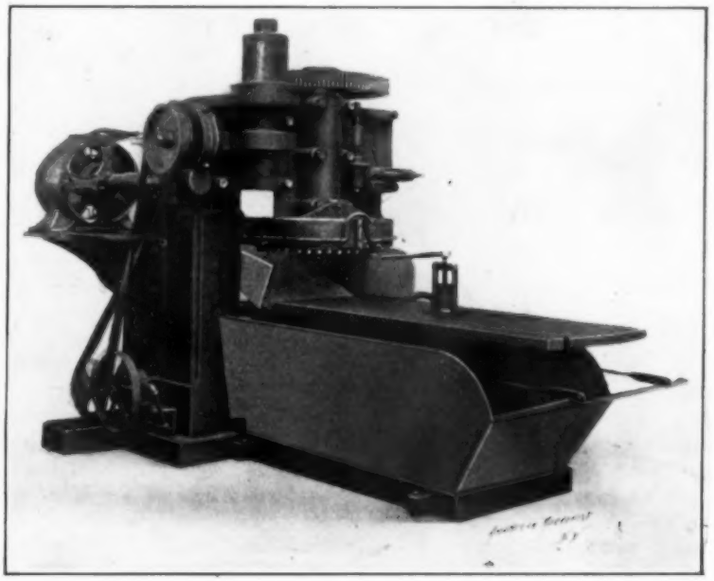


FIG. 3. MACHINE WITH REVOLVING TABLE

power motor having a variation of 750 to 1000 revolutions per minute.

The spindle is mounted on a saddle which has a solid bearing on each upright and vertical adjustment by hand from a minimum distance from bottom of tools to top of the work table of 8 inches to a maximum of 25 inches. The work table is 30 inches wide, 7 feet 3 inches long, having a working surface of 6 feet, and is entirely surrounded by an oil pan. The drive is by means of a spiral gear and rack. The table has nine changes of geared feed ranging from 0.941 to 9.75 inches per minute. Provision is made for hand adjustment and power quick return, or fast traverse in either direction if a reversing motor is used.

In Fig. 3 the machine is taking a cut 14½ inches wide and ¼ inch deep at a lineal advance of the table of 8½ inches per minute. This could be made in cast iron. For conveniently grinding these cutters a grinding machine has been developed which grinds the proper bottom and side rake to the cutting tools at the same time. This is much more convenient than taking out the tools and grinding them as was formerly the practice, as all the tools will be ground alike and remain set in correct position. Smooth finished cuts can be obtained when using much coarser feeds than were before possible. The hand wheels for adjusting the rail and the table, and the levers for engaging the feeds and fast traverse motion are located on the working side of the machine within easy reach of the operator.

Fig. 3 shows another type, one of these machines with an auxiliary table, which can be revolved, allowing work to be set on one end while the work on the other end of the table is being machined, thus giving practically a continuous operation. It will also be noticed that the cutter head moves in a vertical slide, similar to a slotter ram, being driven by a pair of worm wheels at the left of the machine. These are all from the Newton Machine Tool Works, Philadelphia, Penn.

A Large Special Boring Mill

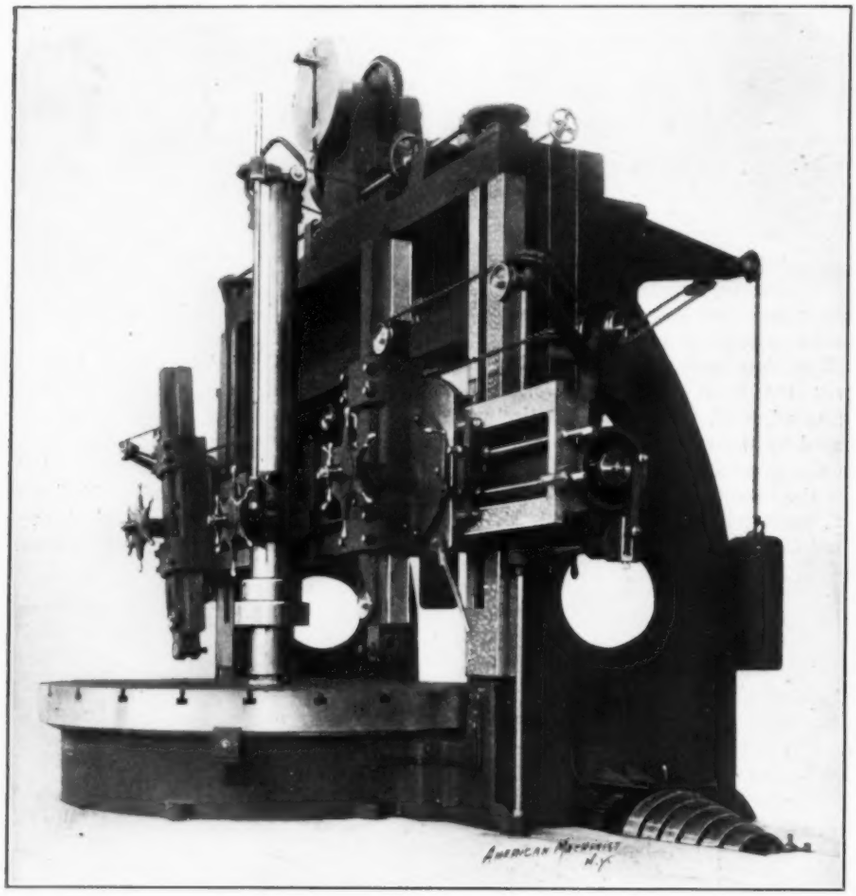
This is a 12-foot boring mill, the actual swing being 12 feet 4 inches, taking work 6 feet 3 inches under tool and 6 feet 9 inches under the crossrail. It is standard except that it has a traveling-head boring bar 12 inches diameter and a slotting attachment which operates on the right-hand tool spindle in the usual way by means of a connecting rod which could not be shown in place on account of the boring bar.

The tool slides are very stiff and have a travel of 48 inches. Each one is counterbalanced by separate chain and weight, making the operation of each entirely independent of the other. Beside this, the balance weight is so arranged that when the weight is once hung it is not necessary to remove for any position of tool spindle or crossrail. This arrangement also provides a clear space between the heads for handling work on the table as the chains are back of the crossrail face, as shown by their position behind the boring bar.

The table, which is 10 feet in diameter, is driven by a 10-foot internal gear bolted separately to the table. This method of driving gives a very smooth motion owing to the greater pinion contact. The crossrail is gibbed to both inside and outside of upright faces. Another handy feature of this machine is the bracket shown on the right-hand side of the saddle. This bracket is bolted to the saddle and slides with it, enabling the operator to make fine adjustment to his tools without going to the end of the crossrail, often saving the services of an extra man. This is a patented device as is the feed arrangement which, though very simple, gives 96 changes varying from 1/64 to 1½, any one of which can be obtained instantly while machine is in motion.

While the majority of these large tools are now motor driven this particular machine was belt driven, having a six-step cone pulley for 4½-inch belt and giving 36 changes arranged in geometrical progression.

It was built by the Betts Machine Company, Wilmington, Del.



A LARGE SPECIAL BORING MILL

A Steel Drafting Table

This has been designed to give a substantial, non-wabbling drawing table, that will not shrink, crack or get out of order. Angle, round and flat iron has been used throughout except for the thin oak strips which form the top and support the drawing board, or it can be supplied with a solid top if desired. It can be folded up flat for storage or easy transportation, but when set up and locked is very rigid and substantial.

It can be had with a hard or soft top,

A STEEL DRAFTING TABLE

up to 21½x28 inches and a parallel straight edge is supplied when desired, as is the bracket and tray, adjustable to any position, shown attached to one of the legs. This is made by the Century Manufacturing Company, Columbus, Ohio, and can be supplied of any length up to 10 feet.

Full Universal Milling Attachment

This universal milling attachment has several very novel features, and the users are very enthusiastic over its performances and its possibilities. Fig. 1 shows the milling spindle in a vertical position, but it can be swung in either position, being graduated in both directions.

The large bevel gear is on a shaft with a taper to fit the machine spindle and drives the large pulley shown in Fig. 3,

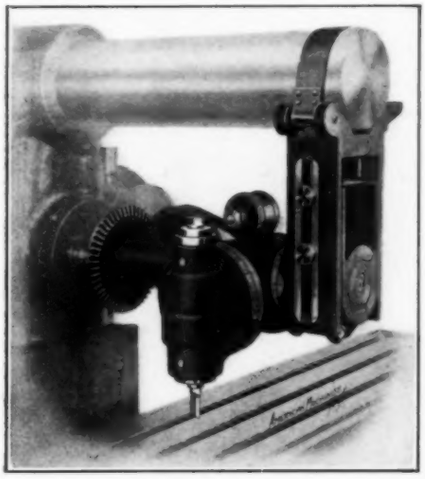


FIG. 1. FULL UNIVERSAL MILLING ATTACHMENT

which is supported by a stud on a boss on the long sleeve running from the large gear to the outer support on the overhanging arm with the driving shaft in the center. An endless belt with its tension

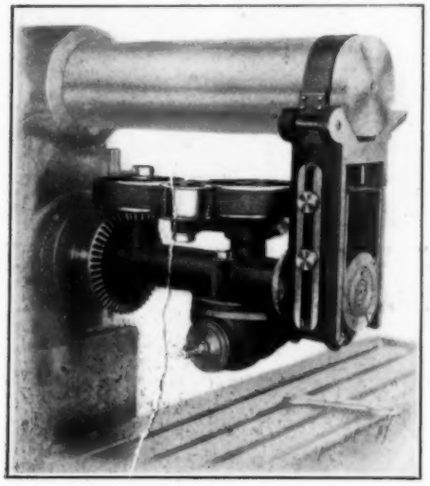


FIG. 2. IN A HORIZONTAL POSITION

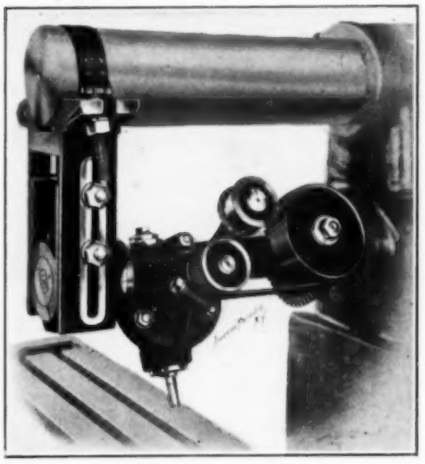


FIG. 3. SHOWING THE BELT DRIVE

controlled by a tightener drives the milling spindle by means of bevel gears, which allow it to be swung into any position around the central driving shaft.

The outer support is interesting in itself, consisting of a bearing whose center distance between the overhanging arm and the spindle is adjustable, and is also adjustable around the long sleeve, holding it and the milling spindle in any desired position with regard to the axis of the main milling-machine spindle. The method of securing to the overhanging

FIG. 4. ANOTHER POSITION

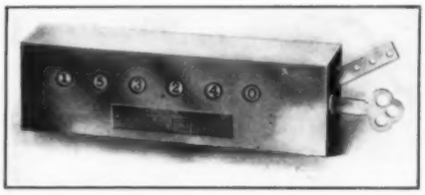
arm is by means of a steel strap, which is now made of a solid piece instead of being riveted as shown. This makes a much better fastening than might be imagined, and holds the fixture in position very rigidly.

Fig. 2 shows this swung into a horizontal position, with the bevel gears and belt very much in evidence, while Figs. 3 and 4 give a good idea of its adaptability to a variety of uses. There is nothing complicated about the device, which will recommend it to those who need a tool of this kind for a variety of work. It is made by the Porter-Cable Machine Company, Pearl and Canal streets, Syracuse, N. Y.

The Root Counter

This counter has been designed to secure simplicity together with positive action and to that end it has but few parts, contains no springs, is locked at every change of figures which prevents jumping, and will run at any reasonable speed. The case is furnished with or without lock, as desired, the lock effectually preventing any tampering with the dials.

The dials can be reset to zero or any number desired by pulling out of the case slightly which unlocks them, and then replacing as before. Very little power is



THE ROOT COUNTER

required, making them particularly useful for light, fast-running machines. They are made by the C. J. Root Company, Bristol, Conn.

Geared Tapper for Drill Press

The gearing of this device includes the regular crown gear on the spindle, a pair of bevel gears on the upper drive shaft

GEARED TAPPER FOR DRILL PRESS

which face in opposite directions, and an intermediate bevel gear which meshes with the rear face of the drive shaft gear. The upper half of this intermediate gear is a spur gear meshing with the spur gear of the spindle and giving the reverse motion. These gears are mounted on the vertical shaft and can be readily disengaged when no tapping is to be done.

In tapping the left hand holds the piece of work, the right hand controls the tapping lever. The forward motion throws the tap into action while the backward motion gives a 2 to 1 reverse. It is very simple, is always in place so that it cannot be mislaid and does not interfere with the regular work of the machine in any way.

This is being applied, with suitable modifications, to the entire line of drills built by the Rockford Drilling Machine Company, Rockford, Ill.

A New Steel Plant for Japan

The new Japanese steel plant of Messrs. Armstrong, Whitworth & Co., of Newcastle-on-Tyne, will shortly be started and will be devoted to the production of high-class steel for gun forgings, etc.

John Noble, son of the celebrated Sir Andrew Noble, formerly a royal artillery officer and a managing director of Armstrong, Whitworth & Co., an acknowledged authority on explosives and artillery, is in Japan inspecting for his firm the new steel works which is located at Muroran.

Messrs. Armstrong have not only built many of the first-class ships of the Japanese Navy, but have supplied much of its armament. The new plant at Muroran is a joint enterprise of Mr. Noble's firm and Vickers, Sons & Maxim and the Hokkaido Tanko Kisen Kaisha. Albert Vickers will shortly join the enterprise.

The new works will be under the direction of experts from the Imperial Japanese Navy with the assistance of specialists from the English works.

It is also expected that Mr. Noble will inspect the explosive factory at Hiratsuka, which is just starting the manufacture of cordite for the Japanese Government. These works have been built by Armstrong, Whitworth & Co., in conjunction with the Nobel Explosive Company, of Ardeer, Scotland.

It is understood that the Japanese Government has pledged itself to support both of the above enterprises by the purchase of a certain quantity of the output annually.

Kobe, Japan. C. A. FANJIN.

Screw Cutting Attachment with Special Cutter for the Lathe

The half-tones illustrate a lathe attachment for cutting screws at one pass of the carriage along the work. The device employs a special form of threading tool clearly shown in Figs. 1 and 2 which is rotated to bring successive cutting points into action while being fed along the work.

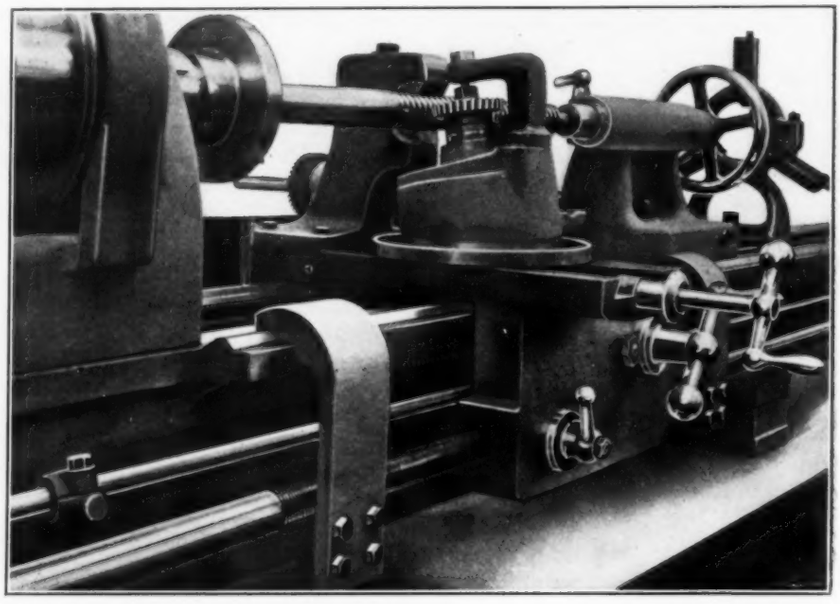


FIG. 2. THREADING ATTACHMENT IN OPERATION

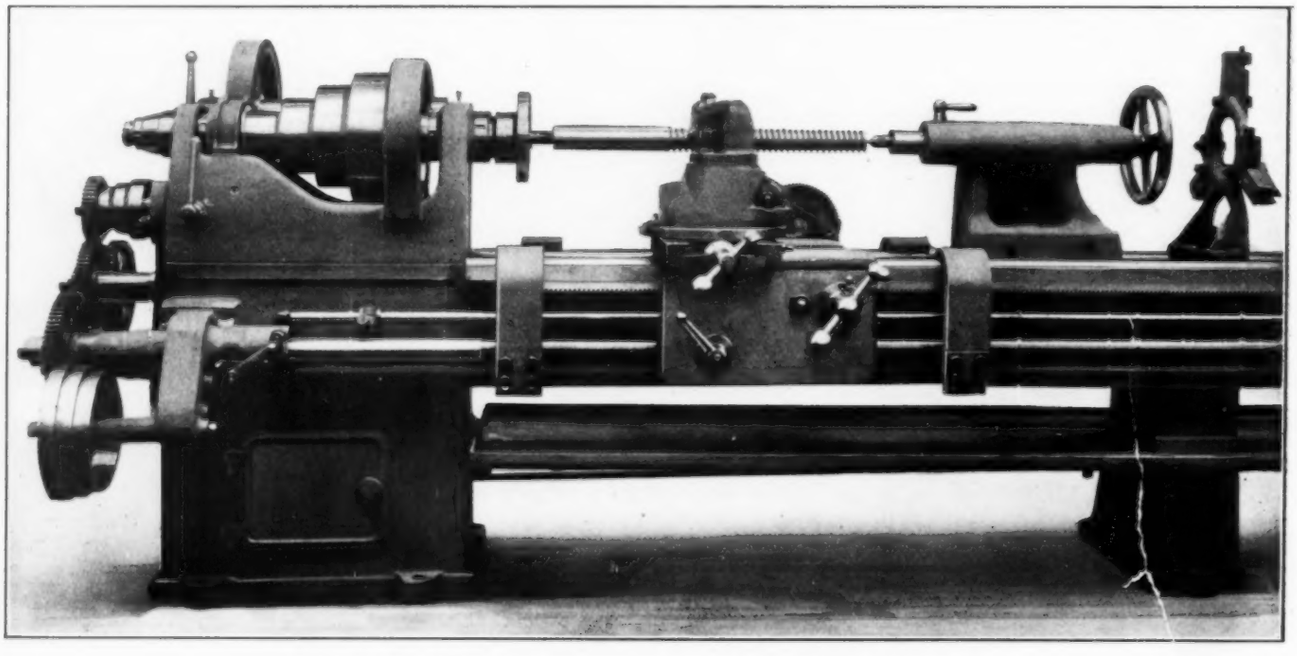


FIG. 1. THREADING ATTACHMENT IN POSITION ON LATHE CARRIAGE

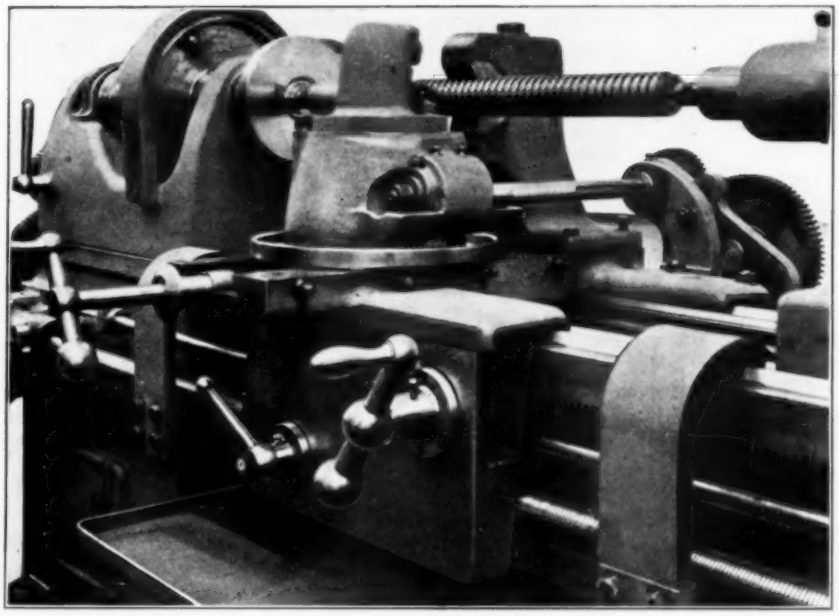


FIG. 3. ARRANGEMENT OF GEARING FOR OPERATING THREADING TOOL

by the movement of the carriage. It is manufactured by Schulfort & Fockedey, Maubeage, France, and known as the "system J. Cornelis."

Fig. 1 is a general view of the attachment in position on the lathe carriage; Figs. 2 and 3 give a better idea of its construction. As represented in Fig. 2, the cutting tool is in the form of a disk with a series of threading teeth about its periphery. This thread tool is mounted on a spindle which is placed perpendicularly to the axis of the work and adapted to be rotated as the carriage is traversed along the shears. The carriage lead screw is geared in the usual manner to suit the lead of the screw to be cut. The threading cutter is geared to rotate at the necessary rate to conform to the lead being cut, by worm wheel and worm driven by change gearing located at the rear of the carriage. This gearing is operated from the spindle of the lathe in the same way that the regular gearing for feeding the carriage is driven. The short shaft connecting the operating worm with the gearing at the rear is splined as shown in Fig. 3 to allow the attachment to be adjusted in and out on the carriage by the cross-feed screw. This illustration as well as Fig. 2 also shows the method of supporting the work against the pressure of the tool during the thread-cutting operation.

Two-Spindle Attachment for Drill Press

By A. L. Lowe

Having the American Machinist on file is a big help to some of us young fellows, who are not perhaps gifted with inventive talent of our own, but who can, with the aid of a good technical paper, employ the ideas and suggestions of others in our own work. A problem that I had to solve will serve as an illustration of this.

In our line of work (water meters and steam goods) a lot of the drilling consists of pieces that require a hole to be drilled in either end as valve yokes, and other pieces such as meter tops having a hole on each side, for the purpose of attaching the register cases.

Close competition called for a reduction in the machine costs of the different operations, and we turned our attention first to the drilling. Our drill jigs were designed for rapid production, and it did not seem possible to make much improvement in that direction.

Looking over some recent issues of the American Machinist I came across C. L. Butler's article at page 427, Vol. 31, Part 2, in which he describes a three-spindle, nonadjustable multiple-drilling attachment for the drill press. As the center to center distance of the holes in our work varied with the size of the valves and meters, we had to have something adjustable and at the same time neither complicated nor expensive.

Fig. 1 shows our attachment in place on the quill of the drill press. As shown, it will drill holes 6 inches from center to center. By loosening the clamp screws the two castings carrying the spindles, drill chucks and small gears can be moved toward each other and clamped in any desired position. It will be seen that the center to center distance of the holes can be varied from 6 inches as the maximum, to the diameter of one of the small gears as the minimum (in this case 2 inches). The diameter of the driving gear is, of course, 4 inches.

Fig. 2 is a top view of one of the spindle frames. Fig. 3 is a side view of what we call a locating stop, which is used in connection with the attachment, Fig. 4 showing a top view of it in use. In setting up for a job, the quill carrying the attachment is brought down, the spindle frames adjusted so that the drills will enter the bushings, and then clamped in place. At the same time the locating stop is bolted down to the table and the set screws adjusted to bear against the stop on the jig, as shown. The locating stop is simply a piece of flat bar iron forged to shape shown and having the three [illegible] for adjustment. The stop on the jig is a piece of square ½-inch stock, and is secured with two screws to the top of the jig near the back. By using the attachment and this stop, the operator is enabled to drill two holes in less time than it formerly took to drill one.

Where the drill press has a rack on the quill it would be necessary to make a bushing the walls of which would be a little thicker than the rack with a section the width of the rack cut out. The use of this attachment necessitates crossing the belt on the drill press.

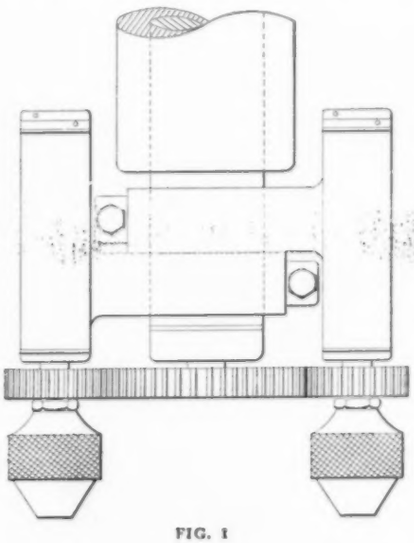


FIG. 1

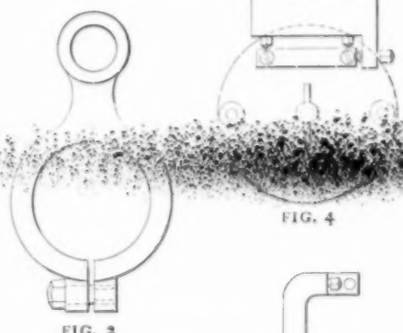


FIG. 4

FIG. 2

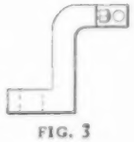


FIG. 3

TWO-SPINDLE ATTACHMENT FOR DRILL PRESS

Derivation and Generalization of Simpson's Rule

By Antonio Llano

Simpson's rule is a rule for the approximate computation of areas and other quantities, such as volumes, work, moments of inertia and the like, that can be represented by areas. Considering the exceeding simplicity of this rule, and the high degree of approximation which it gives, it is surprising that engineers use it comparatively seldom, except, perhaps, in earthwork and other similar calculations, in which the rule is used under the name of *the prismoidal formula.* Indeed, even among engineers that use the prismoidal formula there are but few who know that this formula is but a special case of Simpson's rule.

In American and English books, Simpson's rule is customarily derived by means of advanced mathematics. A much simpler derivation, however, can be obtained by an application of the principle of elementary geometry.

Derivation of the Rule by Geometry

Let it be required to determine, approximately, the area A bounded by a base line OD, Fig. 1, a curve BNC, and two end ordinates OB and DC. The distance OD is supposed to be known. Determine the end ordinates and the ordinate MN at the middle point of OD. Denote these ordinates by y_1, y_2, y_3, as shown, and the distance OM $(=MD)$ by b. The area is to be computed in terms of these four quantities. The other quantities presently to be introduced are only auxiliary quantities used for the derivation of the final formula.

Divide OD into three equal parts OP, PQ, QD, and denote the ordinates PR and QS by z_1 and z_2, respectively. Draw BR, RS and SC. The required area is approximately equal to the sum of the three trapezoids OR, RQ, QC, whose common altitude is equal to OP, or $\frac{1}{3}b$. We have, therefore, as a first approximation,

$$A = \left(\frac{2b}{3} \times \frac{y_1 + z_1}{2}\right) + \left(\frac{2b}{3} \times \frac{z_1 + z_2}{2}\right) + \left(\frac{2b}{3} \times \frac{z_2 + y_3}{2}\right)$$

$$= \frac{b}{3}\left[(y_1 + z_1) + (z_1 + z_2) + (z_2 + y_3)\right]$$

$$= \frac{b}{3}\left[y_1 + 2(z_1 + z_2) + y_3\right].$$

Now,

$$\frac{z_1 + z_2}{2} = ME,$$

$$2(z_1 + z_2) = 4ME.$$

Therefore, the above equation may be written,

$$A = \frac{b}{3}(y_1 + 4ME + y_3).$$

It is obvious that, in the case represented in the figure, the area just computed is a little too small. In order to partly compensate for this error, the ordinate MN, or y_2, is written instead of ME. This gives the much closer approximation

$$A = \frac{b}{3}(y_1 + 4y_2 + y_3). \qquad (1)$$

This is the fundamental formula from which Simpson's rule is derived. Let A, now, denote the area bounded by a base OD, Fig. 2, a curve BFC, and two end ordinates OB, DC. Divide the base into an *even* number of equal parts, as shown, and measure the ordinates at the points of division. Applying formula (1) to the areas on the bases OD_2, D_2D_5, D_5D, and adding the results, we have

$$A = \frac{b}{3}(y_1 + 4y_2 + y_3) + \frac{b}{3}(y_3 + 4y_4 + y_5) + \frac{b}{3}(y_5 + 4y_6 + y_7),$$

or, collecting terms and factoring,

$$A = \frac{b}{3}\left[y_1 + y_7 + 4(y_2 + y_4 + y_6) + 2(y_3 + y_5)\right] \qquad (2)$$

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or, collecting terms and factoring,

$$A = \frac{b}{3}\left[y_1 + y_7 + 4(y_2 + y_4 + y_6) + 2(y_3 + y_5)\right] \qquad (2)$$

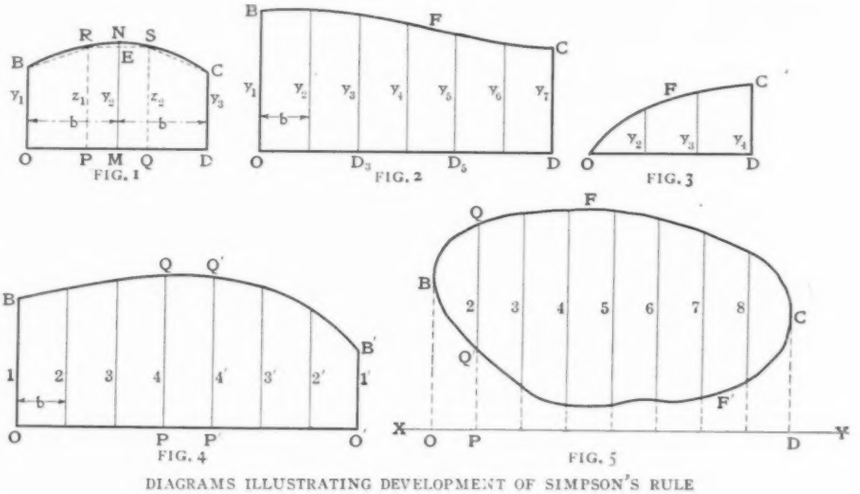

FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5

DIAGRAMS ILLUSTRATING DEVELOPMENT OF SIMPSON'S RULE

As will be observed, the quantity within the brackets is the sum of the end ordinates, four times the even ordinates, and twice the odd ordinates. It is obvious that an expression formed according to the same law will be obtained whatever the number of divisions may be, provided this number is *even*. The process may be stated in the following general rule, which is Simpson's rule:

Divide the base into an even number of equal parts, and determine the ordinates at the points of division. Form the sum of the end ordinates, four times the intermediate even ordinates, and twice the intermediate odd ordinates. Multiply this sum by one-third the distance between two consecutive ordinates. The result will be the required area.

A very convenient way to remember which of the sums is to be multiplied by 4 and which by 2 is this: The sum of the *even* ordinates is to be multiplied by 4, or 2^2, which is an *even* power of 2; while the sum of the *odd* ordinates is to be multiplied by 2, or 2^1, which is an *odd* power of 2.

If the curve starts from the base, as in Fig. 3, the first ordinate should be considered to be zero. The same remark applies to the end ordinate, if the end of the curve is on the base.

Generalization of the Rule

Special rules and formulas have been devised to compute the area when the number of divisions is odd. But this multiplication of rules, being inconsistent with simplicity, is undesirable. It will now be shown how, by an application of Simpson's rule, a more general rule can be obtained that applies to both an even and an odd number of divisions.

Let the base OO', Fig. 4, be divided into an odd number of parts (in this case seven). Mark the ordinates on each side of the center, beginning with the limiting ordinates OB and $O'B'$, with the consecutive numbers 1, 2, 3, etc., using, for convenience, primed numbers on one side. In what follows, the ordinates 1, 2, 3', etc., will be donated by y_1, y_2, y'_3, etc. The figure $PQQ'P'$ will be referred to as the "center strip." An ordinate will be called even or odd according as it is represented in the figure by an even or an odd number, whether primed or not. The sum of *all* the even ordinates will be denoted by S_2, and the sum of *all* the *intermediate* odd ordinates (that is, excluding y_1 and y_1') will be denoted by S_1.

Applying Simpson's rule, and taking the area of the center strip equal to $b(y_4 + y_4') \div 2$, we have

$$A = OBQ'P' + O'B'QP - PQQ'P',$$

$$= \frac{b}{3}\left[y_1 + y'_1 + 4(y_2 + y_4) + 2y_3\right] + \frac{b}{3}\left[y'_1 + y_4 + (y'_2 + y'_4) + 2y'_3\right] - \frac{b(y_4 + y'_4)}{2},$$

or, after some simple reductions,

$$A = \frac{b}{3}\left(y_1 + y'_1 + 2^2S_2 + 2^1S_1 - \frac{y_4 + y'_4}{2}\right).$$

A similar formula applies whenever the number of strips on each side of the center strip is odd; that is, whenever the ordinates of the center strip are even.

Let us now consider the case in which the number of strips on each side of the center strip is even. We shall assume the number of divisions to be 9. The area on each side of the center strip can then be computed by Simpson's rule, and the total area is equal to the sum of the two areas thus obtained plus the area of the center strip; that is,

$$A = \frac{b}{3}\left[y_1 + y_5 + 4(y_2 + y_4) + 2y_3\right] + \frac{b}{3}\left[y'_1 + y'_5 + 4(y'_2 + y'_4) + 2y'_3\right] + \frac{b(y_5 + y'_5)}{2},$$

or, after reduction,

$$A = \frac{b}{3}\left(y_1 + y'_1 + 2^3 S_3 + 2^1 S_1 + \frac{y_5 + y'_5}{2}\right).$$

The following general rule can now be stated; it is understood that the notation here adopted is used:

Add the extreme or limiting ordinates, 4 times the even ordinates, and 2 times the odd ordinates. If there is a center strip, add or subtract the mean of its ordinates, according as they are odd or even. Multiply the result by one-third the common distance between the ordinates.

It is easy to remember whether the mean of the ordinates of the center strip should be added or subtracted, by remembering that, when these ordinates are odd, the formula is derived by applying Simpson's rule to the part of the figure on each side of the center strip, and then *adding* the area of the center strip.

The foregoing rule is probably simpler than a formula. For the benefit, however, of those that like to see every rule expressed in algebraic symbols, a general formula will be given.

Let y_m, y'_m denote the ordinates nearest to the center; if the number of divisions is even, these two ordinates may each be taken equal to the center ordinate. Let the remainder obtained by dividing by 2 the number of divisions be r. If the number of divisions is odd, $r = 1$; if even, $r = 0$. Then, remembering that an odd power of a negative quantity is negative, and an even power is positive, we may write

$$A = \frac{b}{3} \times \left[y_1 + y'_1 + 2^3 S_3 + 2^1 S_1 - (-r)^m \frac{y_m + y'_m}{2}\right].$$

Whenever practicable, an even number of divisions should be used instead of an odd number, as the formula for an even number is generally more accurate. In this case, the subtractive term in the formula disappears, since $r = 0$. Besides, the ordinates may, in this case, be numbered consecutively from either end, there being no special advantage in beginning with 1 at each end, as in the case of an odd number of divisions.

Area of a Closed Curve

The area of a closed curve $F F'$, Fig. 5, can be computed readily as follows: Let $X Y$ be an arbitrary line drawn outside the figure in any convenient direction, or else a line of reference forming part of the figure. Draw the two end ordinates $B O$ and $C D$, just touching the curve at B and C. The required area is the difference between $O B F C D$ and $O B F' C D$. When the expression for each of these areas is written, and the difference between the two expressions is taken, the result will have the same general form as either of the two expressions, except that the ordinates will be replaced by the parts of them intercepted by the curve. In this case, then, it is only necessary to measure the intercepts, such as $Q Q'$, between the upper and the lower curve, and substitute them in the general formula, or apply to them the general rule. Thus, with the notation shown in Fig. 5 (here both y_1 and y_5 are zero), the area of the closed curve is,

$$\frac{b}{3}\left[4(y_2 + y_4 + y_6 + y_8) + 2(y_3 + y_5 + y_7)\right].$$

If the line $X Y$ is not given as part of the figure, it may be chosen arbitrarily, and drawn in any convenient position, as it is used merely for marking off the common distance between ordinates.

In the case of a reëntrant curve, such as that shown in Fig. 6, the same general principle applies as was explained for Fig. 5. The value of y_7, for instance, is the sum of $Q Q'$ and $R R'$. In cases of this kind, however, it is often better to divide the area into several comparatively simple figures, and treat each figure by itself.

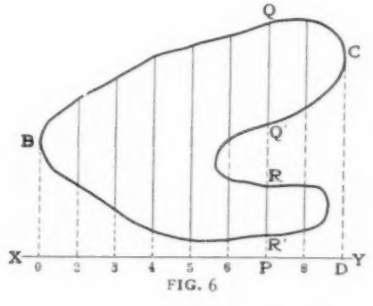

FIG. 6

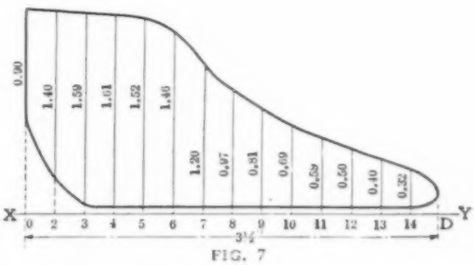

FIG. 7

DIAGRAMS ILLUSTRATING USE OF SIMPSON'S RULE

Application to an Indicator Diagram

To illustrate the application of the rule, let us take the indicator diagram shown in Fig. 7. The length, 3.5 inches, was divided into 14 equal parts, and the ordinates, when measured, were found to have the lengths (inches) marked in the figure. In this case,

$$b = \frac{3.5}{14}, \quad \frac{b}{3} = \frac{3.5}{3 \times 14}, \quad y_{15} = 0.$$

Therefore,

$$A = \frac{3.5}{3 \times 14} \times \left[0.9 + 4(1.40 + 1.61 + 1.46 + 0.97 + 0.69 + 0.50 + 0.032) + 2(1.59 + 1.52 + 1.20 + 0.81 + 0.59 + 0.40)\right] = \frac{3.5}{3 \times 14}(0.9 + 4 \times 6.95 + 2 \times 6.11) = \frac{3.5}{3 \times 14} \times 40.92.$$

The *mean ordinate* is an ordinate which, when multiplied by the length of the diagram, will give the area A. Denoting it by y_m, we have

$$y_m = \frac{A}{3.5} = \frac{40.92}{3 \times 14} = 0.974 \text{ inch.}$$

The mean pressure p, used in computing the power of the engine, is equal to the mean ordinate multiplied by the spring number of the indicator. Assuming this number to be 30, we have

$$p = 30\, y_m = 30 \times 0.974 = 29.2$$

pounds per square inch.

The customary way of finding y_m is to divide the length of the diagram into equal parts, draw and measure the even ordinates, and divide their sum by their number. In the present case, this method gives

$$y_m = \frac{6.95}{7} = 0.993 \text{ inch};$$

$$p = 30 \times 0.993 = 29.8 \text{ pounds per square inch.}$$

As will be observed, the difference in the values of p found by the two methods is about 2 per cent. (over 3 per cent. if pressures are taken to the nearest pound). If the modification of Simpson's rule for an odd number of divisions is applied, we get, taking the number of divisions as 7,

$$y_m = \frac{A}{3.5} = \frac{1}{3 \times 7} \times \left[0.9 + 4(1.59 + 1.20 + 0.81 + 0.40) + 2(1.52 + 0.59)\right] = 0.958 \text{ inch.}$$

$$p = 30 \times 0.958 = 28.7 \text{ pounds per square inch.}$$

In the practical application of the rule, it is neither convenient nor accurate, when the ordinates have to be determined by actual measurement, to measure every ordinate separately. The best way to proceed is to mark on the edge of a long piece of paper, in succession, all the even ordinates, then measure the distance between the first and the last mark, and

multiply the result by 4. Similarly for the first and last ordinate, and for the odd ordinates.

Other Applications

It will now be shown how Simpson's rule (by which is here meant either the original rule, or the generalized rule and formula given above) can be applied to the computation of other quantities than areas. In all that precedes, the quantity b is equal to $\frac{B}{n}$, denoting the whole length of the base by B and the number of divisions by n. If any of the ordinates is denoted by y, the area between that ordinate and the next one on either side is approximately equal to $b\,y$, or $\frac{B}{n} \times y$. Therefore, if any quantity Q whose value depends upon another quantity B is such that, by dividing B into a large number n of equal parts, the quantity Q is divided into n parts, the value of each of which is approximately equal to $\frac{B}{n}$ multiplied by a variable quantity y, the successive values of y being the more nearly equal the greater the number n is taken, then the approximate value of Q can be determined by substituting in Simpson's rule $\frac{B}{n}$ for b, and the values of y for the ordinates.

Suppose, for example, that it is required to determine the moment of inertia of the area $O\,B\,F\,C\,D$, Fig. 2, about the base $O\,D$. It should be remembered that if b and h are, respectively, the base and altitude of a rectangle, the moment of inertia of the rectangle about the base is $\frac{b\,h^3}{3}$. If y denotes any of the ordinates in Fig. 2, the moment of inertia of the strip on either side of y is, approximately,

$$\frac{b\,y^3}{3} = \frac{B}{6} \times \frac{y^3}{3} = \frac{B}{18} \times y^3.$$

Replacing, in Simpson's rule, b by $\frac{B}{18}$, and the ordinates by their cubes, the moment of inertia of the whole figure is, approximately,

$$\frac{B}{54}\left[y^3_1 + y^3_7 + 4\,(y^3_2 + y^3_4 + y^3_6) + 2\,(y^3_3 + y^3_5)\right]$$

The Prismoidal Formula

Consider, as another illustration, a solid of length B, bounded by two parallel cross-sections of areas A_1 and A'_1. Such solids frequently occur in the computation of earthwork, of the capacity of reservoirs, and of the displacement of vessels. If the length of the solid is divided into a large number n of equal parts, and the cross-sections at the points of division are determined, the volume between any cross-section A and the next one is, approximately, $\frac{B}{n} \times A$. Therefore, Simpson's rule can be applied in computing the approximate volume of the solid, by using $\frac{B}{n}$ instead of b, and the areas of the cross-sections instead of the ordinates. In the special case in which the length of the solid is divided into two parts,

$$\frac{B}{n} = \frac{B}{2}, \quad \frac{b}{3} = \frac{B}{6},$$

and the volume V is given by the formula

$$V = \frac{B}{6}\left(A_1 + 4\,A_2 + A'_1\right).$$

This is the *prismoidal formula.*

Safety Valves—Discussed by the American Society of Mechanical Engineers

The February meeting of the American Society of Mechanical Engineers was held on the evening of the 23d, in the Engineering Societies building.

The subject "Safety Valves" was opened by Frederic M. Whyte, general mechanical engineer of the New York Central lines. His presentation was from the side of locomotive practice. He was followed by L. D. Loverkin, chief engineer, New York Shipbuilding Company, who developed the requirements of safety valves for marine use and presented a formula for the capacity or rating of such values, originated by him and in considerable use in marine engineering practice. He stated that the escape pipe should have an area in the proportion of ½ to 1 with the effective valve area.

Philip G. Darling presented a paper, illustrated by lantern slides, describing extensive tests made with safety valves under working conditions. The gist of these papers was: Safety valves as rated today by size do not have uniform capacities for the same rating—there may be differences as great as 300 per cent.; a rational formula for capacity is needed, based upon the flow of steam through the valve orifice, and in selecting a suitable valve for a given boiler the evaporative capacity of the last should be the factor used; the marking of valves as to capacity should be uniform and based upon a universally adopted formula or experimental method of rating.

Discussion was animated and general. Advocates of the high-lift and low-lift valves took opposing sides and freely expressed their opinions. Safety-valve springs were considered and treated as a vital element of the design. Two suggestions were made that are of interest: Dr. Luke suggested that one of the fruitful fields of investigation of a society research committee would be safety valves. He pointed out the need of such a committee and stated his belief that it would soon come into existence.

Professor Rockwood suggested for the benefit of the representatives of boiler-insurance companies that their organizations might follow the lead of the underwriters and have an experimental laboratory for the purpose of investigating devices that would tend to minimize accidents in their field. Safety valves might properly be one of the first devices taken under consideration by such a laboratory.

A. T. Kruse

A. T. Kruse, vice-president and general superintendent of the American Steel Package Company, died on February 18, as a result of an accident with which he met when a gas meter on which he was conducting some tests exploded.

Mr. Kruse was a mechanic of unusual ability and his inventive nature has been largely responsible for the improved steel cases and barrels manufactured by his company.

Mr. Kruse was but 35 years old, and took up the machinist's trade at the Toledo Machine and Tool Company works of which city he was a native. In a short time his mechanical ability was recognized, with the result that he held important positions with several firms and on the organization of the American Steel Package Company he became its vice-president and general superintendent.

Business Items

A new corporation to be known as the McCabe Machine Company has been formed with headquarters at 95 Liberty street, New York City. The company will deal in new and second-hand machine tools and will have as its president and treasurer, Peter A. McCabe, and as secreary, George M. McCabe. Thomas M. Kane is also a member of the firm.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

Test indicators. H. A. Lowe, Cleveland, O.

Small die and sheet stampings. Whitman & Hunter, Ypsilanti, Mich.

We buy or pay royalty for good patented machine or tool. Box 282, Amer. Mach.

Hand and power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Engineers' handbook of tables, details and machinery; price, $3.50. M. Neumayer, M. E., Cincinnati, O.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—Engine lathe, 24″ to 28″x14′ or more; also 14″ to 16″x8′ or more. Shartle Bros. Machine Co., Middletown, Ohio.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

Machinery designed and improved by technical expert; graduate electrical and mechanical engineer. Working drawings, patterns and castings furnished. R. P. Clarkson, Beverly, Mass.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Lathe, planer and milling machine work, gear cutting, etc., solicited; or machines built complete, by a shop making high-grade machine tools. Estimates furnished. J. F. Bowman, Box 4, Station B, Cincinnati, Ohio.

Are you staggering under a heavy burden? Are you vexed to find, that with all your expenses, you are not getting results? It is my business to design and build tool equipments, to devise methods of manufacture. Address Box 975, AMERICAN MACHINIST.

In order to settle an estate an attractive opportunity is open to a party with $150,000.00, competent to fill responsible position either in the sales or manufacturing department, to purchase an interest in a well and favorably known, profitable machinery manufacturing plant located in Pennsylvania, with an office and established trade in New York City. Address "Executors," care of AMERICAN MACH.

Wanted—To communicate with manufacturers or others interested in the development of the 2-cycle gas or internal combustion engine, scavenging at all speeds without baffle plate or waste of explosive mixture, giving a larger volume and slightly longer stroke with 50 to 75 per cent. estimated increase of power for same bore and revolutions per minute over the present types of 2- and 4-cycle engines; will not back fire; adaptable to all power purposes, and patentable. Especially adapted to high-grade autos or power boats. Address Chas. H. Inman, care Trenton Pattern Works, Trenton, N. J.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

An experienced designer on machine tools, stamping presses, automatic machines, tools and fixtures, wants work in the Chicago district. Box 982, AMERICAN MACHINIST.

IOWA

Young man with practical and technical training and experienced in drafting, pattern-making, designing and general machine shop work desires employment in designing and making tools and jigs for interchangeable manufacture, or designing small and medium machinery. Well up on gas engine work and prefer that line. Best references. Now employed. Middle West preferred. 702 South Clark St., Iowa City, Iowa.

MASSACHUSETTS

First-class tool forger wants position. Expert on high-speed steel, etc. Can take charge. Address "Forger," AMERICAN MACHINIST.

I wish to correspond with any company desiring the services of a progressive and up-to-date manufacturing superintendent. Box 953, AMERICAN MACHINIST.

Mechanical and electrical engineer, technical education, 10 years' experience designing and manufacturing. Desires to change position. Box 966, AMERICAN MACHINIST.

MICHIGAN

Situation Wanted—A-1 toolmaker and designer, superintendent or foreman. Am now employed. Detroit territory preferred. Box 970, AMERICAN MACHINIST.

NEW JERSEY

Mechanical draftsman, 27, graduated, 5 years' experience, 1 year shop, wishes position A-1 (first-class) references. Any location. Box 976, AMERICAN MACHINIST.

Technical graduate, 20 years' experience as mechanical engineer, master mechanic and superintendent of construction in mill work, desires position; best of references. Box 958, AMERICAN MACHINIST.

NEW YORK

Draftsman, experienced, seeks position. Bo 962, AMERICAN MACHINIST.

First-class draftsman, technical education; Corliss or high-speed engines, wants position. Box 980, AMERICAN MACHINIST.

Draftsman wishes position; 11 years' drawing room experience, 6 years in connection with introducing system. "System," Box 977, AMERICAN MACHINIST.

First-class diemaker, twenty years' experience, specialty round work, would like position with manufacturing concern; reference. Box 981, AMERICAN MACHINIST.

Inventor and mechanical engineer with wide experience devising simple and ingenious mechanisms to accomplish intricate results, desires to correspond with Corporations and others having devices to perfect. Excellent facilities for experimenting in mechanics and electricity. Address Box 971, AMERICAN MACHINIST.

OHIO

Mechanical engineer with experience as designer, chief draftsman and superintendent, wants change. Technical training, shop practice and good executive ability. Prefer company that wants to manufacture pumps, compressors and engines from my design or wants to improve their line. Box 946, AMER. MACH.

Engineer of established reputation, wide experience apprentice to works manager, intimate knowledge of best shop and machine tool practice on heavy work, gilt-edged record, is open for engagement as works manager with full responsibility and can deliver the goods. Box 865, AMERICAN MACHINIST.

OREGON

Master mechanic, responsible, live man, with extensive experience in the manufacture of high grade machinery and large construction works, smelters, steel works, power plants, railroads, cement and other mills, in the States, Canada and South America; age 40. Box 720, St. Johns, Oregon.

PENNSYLVANIA

Foreman; have been successful handling men, and especially boys, in light and medium interchangeable manufacturing. Am all-round toolmaker and designer; age 29; married. Reference. Box 983, AMER. MACHINIST.

Draftsman and designer (32) wishes position; 10 years' experience; general and hoisting machinery, shop layouts, respeeding machine tools, shop standards, etc. "M. E.," Box 978, AMERICAN MACHINIST.

First-class designer and draftsman with 12 years' experience on steam turbines, steam engines—marine and stationary, general arrangement plans and auxiliary machinery; desires to change. Box 951, AMERICAN MACHINIST.

As general superintendent with large manufacturers or builders of heavy or medium work; replies desired only from those who can use a man of A-1 ability and large experience along these lines. Box 969, AMERICAN MACHINIST.

Machinist, expert toolmaker, diemaker, 15 years' experience, ingenious, inventive, labor-saving devices; 5 years' foremanship experience, wants position. Highest references. Foreman's position preferable. "Expert," 551 Tree St., Philadelphia Penn.

WISCONSIN

Progressive, up-to-date machine shop foreman desires change. Location immaterial. Experienced tool and die maker. Address, "Results," AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Thoroughly up-to-date first-class man to set piece work prices in a large electrical factory in Canada. Applicant must state experience in this line as well as other lines and references; also salary required. None but first class men need apply. Box 972, AM. MA.

Wanted—Director for the Hamilton Technical Institute, one having sufficient experience in technical education to organize and conduct a first-class, new, up-to-date institution. Duties to commence at Easter. Applications received up to March 15th. Apply, stating experience, qualification and salary expected, to R. H. Foster, Esq., Sec'y Bd. of Education, Hamilton, Canada.

Superintendent Wanted—Experienced manufacturing and assembling adding machines, typewriters or small tools. Must be educated in mechanics, experienced and qualified to lay out and direct work and to handle men. Should understand factory organization, shop production and economy. Write, stating experience, place and date of birth and salary to go to Canada. Good opportunity and chance for advancement to a wide-awake, progressive man. Address "L. A. W.," care AMERICAN MACHINIST.

INDIANA

Wanted—4 toolmakers, 6 lathe men, 1 foreman. Good wages, steady employment. Box 943, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Machinist, experienced as toolmaker and foreman. Address stating age, experience and pay required. Box 944, AM. MA.

Wanted—A toolroom foreman thoroughly experienced in toolmaking and in modern toolroom methods. Must have first-class executive ability. Old established manufacturing concern in suburb of Boston, Mass. Open shop. None but experienced high grade foremen need apply. "Foreman," Box 3536, Boston.

MICHIGAN

Wanted—As assistant general manager, a man experienced in the manufacture of marine engines, must also be good office and road salesman. Box 979, AMER. MACHINIST.

Wanted—Working foreman for die department of manufacturing company. Will have five to ten men under him to start. Must be high-grade lathe and bench hand and understand how to design and make all kinds of blanking, forming and combination dies. Position is permanent. Married man preferred. State experience fully and give references. Box 968, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Two competent draftsmen familiar with printing presses or kindred machinery. State age, references, experience and salary. Box 945, AMERICAN MACHINIST.

Salesman—A traveling salesman who is now selling the machine or railroad supply trade, to carry a high-grade bearing metal (babbitt) as a side line, on liberal commission basis. Address, with full particulars, Lakewood Metal Co., Box 182, Lakewood, N. J.

NEW YORK

Wanted—First-class die maker. Steady employment to right man. Standard Optical Co., Geneva, N. Y.

Draftsman—Young man who has had one or two years drafting; also one or two years at machinist trade. Box 967, AMER. MACH.

Wanted—First-class blacksmith and tool dresser, one who understands high-speed tool steels. Shop in small country town. Applicant must state age, wages expected and give references. Box 964, AMER. MACH.

Foreman—Machine shop manufacturing hydraulic machinery. Up-to-date man who has made good; capable of designing jigs and fixtures and systematizing shop. State full particulars regarding age, experience and salary expected. Address "Hustler," AMERICAN MACH.

Chief draftsman; we want a man who has had extensive experience on both small and large work along the line of motors, generators and other electrical machinery. He should be a good executive and thoroughly up-to-date. Write in confidence, giving full information, age and salary expected. Box 959, AMERICAN MACHINIST.

Wanted—As instructor in molding and foundry work at an Eastern technical school, an expert and ambitious foundryman. Must have an unusual degree of information and practical skill, and must have had experience in handling men as foreman of small shop. Also must be a man of fine character, good personality, good general education, and have some natural ability for imparting information. Good salary and splendid opportunity for the right man. Apply, stating age, nationality, education in detail, to "X. Y. Z.," care AMERICAN MACHINIST.

OHIO

Wanted—An A-1 jobbing machinist on special work, with prospect of advancement for man who can handle help. Cincinnati man preferred. Address "F. G. L.," AM. MACH.

Draftsman Wanted—Immediately, experienced in detailing Corliss cylinders and valve gears. State experience and salary expected; also submit sample of work. The Heisler Co., St. Marys, O.

Machinist-foreman with experience on Corliss engines; must be thorough mechanic, sober and industrious, capable of handling men. Give references as to experience, state age and salary expected. The Heisler Co., St. Marys, O.

PENNSYLVANIA

Wanted—First-class, energetic foreman, to take charge of machine shop employing 100 men, on light and medium heavy special machinery. State age, experience, salary expected, references and when you can start work. Box 950, AMERICAN MACHINIST.

Wanted—A competent shop manager who is practical enough to secure maximum production at minimum cost, and who has suf-

ficient business capacity to manage office and handle finances of a company doing $250,000 business annually. All replies treated strictly confidential. Box 984, AMER. MACHINIST.

Wanted—Chief draftsman of good designing ability. A first-class man with wide experience covering hoisting engines and general machinery, boiler and steam plants. Prefer a man with college education and of good executive ability. Good salary to a first-class man. In replying state experience and age, giving full particulars. Box 956, AMERICAN MACH.

Engineers, draftsmen and machinists who appreciate country life, for combined engineering, farm and school work on a sanitary dairy and poultry farm in Bradford county, owned by a mechanical engineer doing standard and original designing. Co-operative. Natural food supplied. No tobacco. Write what you can do, description and what you want. Box 974, AMERICAN MACHINIST.

RHODE ISLAND

Wanted—By cotton machine builders, energetic, reliable, practical man, who understands cotton spinning and manufacturing; one preferred with good technical education who has had experience as master mechanic and thoroughly understands power plants and electricity. Box 973, AMERICAN MACHINIST.

For Sale

For Sale—Three 1 inch Worthington duplex plunger, all brass, hot water test meters. W. H. Odell, M. E., Yonkers, N. Y.

Valuable Canadian Patent—On labor-saving machine being rapidly introduced in the United States. Reynolds Machine Co., Moline, Ill.

Patents for sale of heavy machine tools well introduced or owner will take part cash, royalty or stock in a company of responsibility. Box 942, AMERICAN MACHINIST.

For Sale—A Warner & Swasey No. 6 screw machine, nearly new; two Bardons & Oliver small screw machines, three engine lathes, one 18" shaper, one 8 H.P. Callahan gas engine. Address Box "A 77," care AMER. MACHINIST.

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Marine Turbine Blading and Shipyard Tools

New, Simple and Effective Blading Used for the North Dakota, and Special Machines at the Fore River Shipbuilding Company

EDITORIAL CORRESPONDENCE

The "North Dakota," which is now building in the yards of the Fore River Shipbuilding Company, Quincy, Mass., is to be one of our great battleships. In keeping with the advancement of marine engineering, she is to be equipped with steam turbines and these are to be of the Curtis marine type. The hull of this fighting machine has been launched for some time and at this writing is being fitted with armor, ordnance and machinery. The machine shop of the yard presents a most interesting appearance and richly repaid an editorial visit. The immense turbines are well under way in the various processes of construction, and undergoing various operations of machining and assembling are the shafts, wheels and sections of the turbine casing.

The "North Dakota" is to be a twin-screw battleship equipped with two Curtis marine turbines, each having a rating of 12,500 horsepower, or 25,000 horsepower for the vessel. The initial steam pressure is to be 260 pounds and this is to be expanded down to 28 inches of vacuum. There are to be 9 turbine stages in addition to a special system of turbine wheels to be used for reversing. Each stage with the exception of the first has three rows of buckets or blades; the first stage has four rows. Each set of blades is on an independent wheel with the exception of the last three stages which are combined on a large drum. In addition to these, there are two wheels that are provided for reversing. These run in vacuum when the turbine is running ahead.

For this article we have selected the new form of turbine blading which has been developed by the Fore River people and largely through the efforts of Mr. Rice, together with three special machine tools. This blading is simple, easy to manufacture, that is, it presents no difficult machining operations and promises to be most effective in use. The blades themselves are made from extruded stock produced by a brass manufacturing firm in Connecticut for the especial needs of turbine blades. The bases and shrouds are made of steel.

Fig. 1 is a detailed and assembled view of a section of this blading. In the central part of the figure above the letter *A* can be seen several blades of different lengths with the ends milled to enter the steel channel-shaped base on the one end and the shroud on the other. The letter *B* indicates a piece of the steel channel-shaped base in which the channel has been milled and the sides have been grooved. The letter *C* indicates another piece of this back which has been punched for riveting in the blades. At *D* can be seen a section of the blading where the blades have been riveted into the base.

It will be noticed that a series of saw-cuts have been made through the legs of this channel-shaped piece in order to provide flexibility. The degree with which this flexibility is obtained is very well illustrated by the large section of blading at the bottom of the illustration. This section has been supported at the center and conforms itself to a curve of comparatively short radius merely by the action of its own weight. In fact the amount of flexibility that these sections of blading have, after they have been assembled and slitted, is surprising; this clever device of sawing through the back of the channel in order to obtain flexibility and thus permit of shaping the blades to the positions which they are to occupy, in both wheels and casings, contributes a great deal to the success of the blading system. The

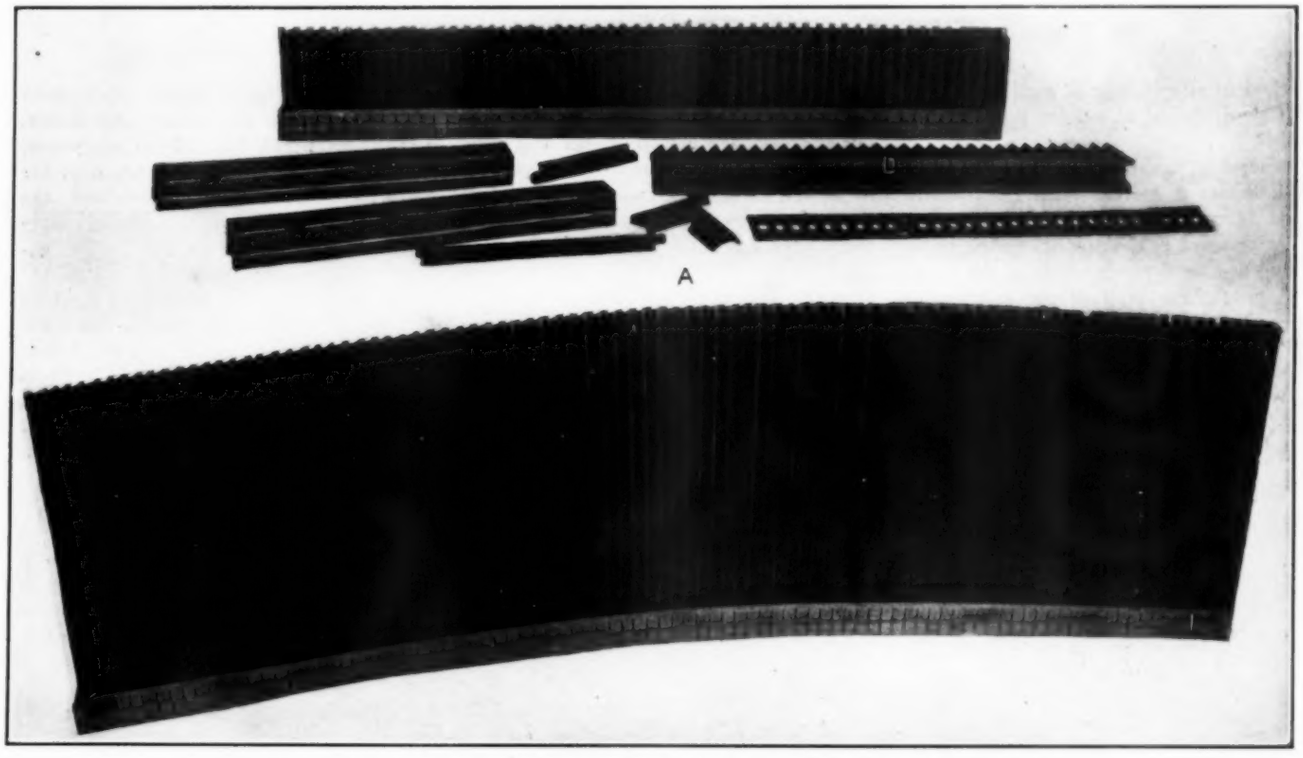


FIG. 1. A NEW FORM OF BLADING FOR CURTIS MARINE TURBINE

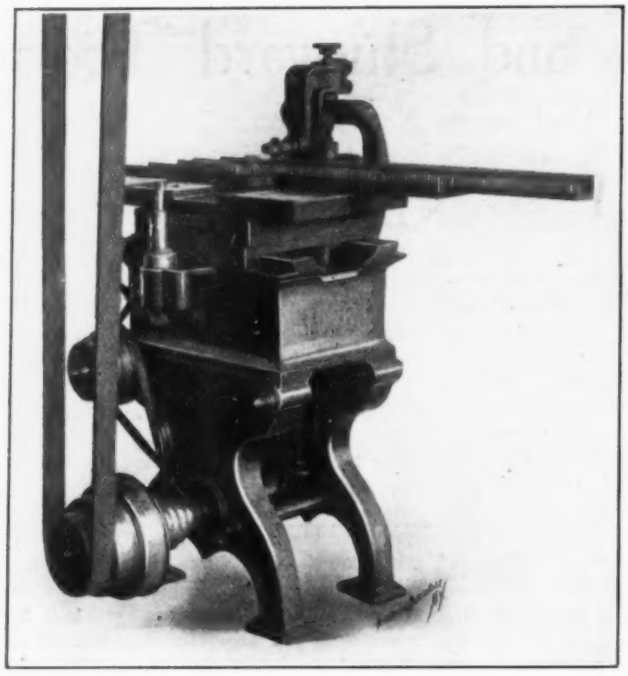


FIG. 2

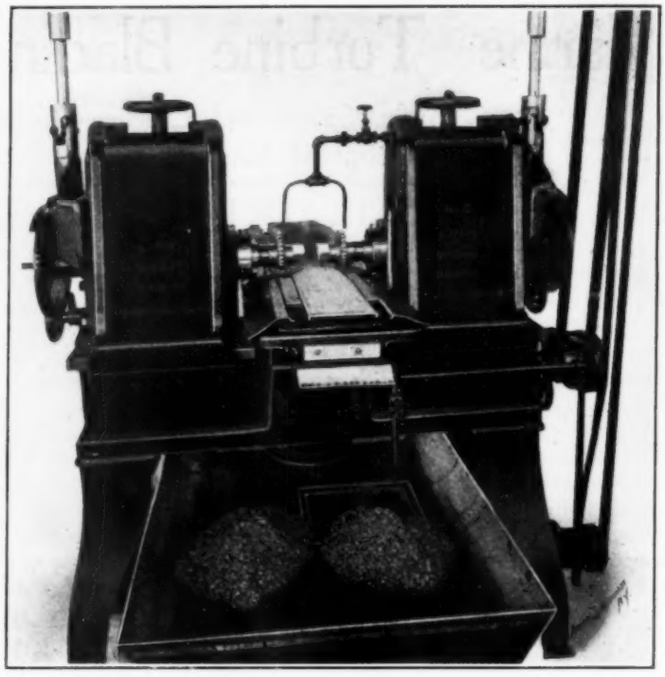


FIG. 3

MILLING MACHINES FOR BASE OF THE BLADING

method of attaching each section in place will be described at a later point in this article.

Referring again to Fig. 1, the letter *E* indicates a section of the shrouding. This is merely a thin, steel strip with holes punched to the proper spacing in order to fit over the outer ends of the blades and hold these in a proper relationship one with another.

Manufacturing the Sections of Blading

The manufacture of the blades themselves is so simple that no further description is necessary beyond what has been said; they are made from specially produced stock, are cut to length and have the ends milled in order to rivet into the backs and shrouds. Similarly the shrouds themselves are steel strips cut to length, with punched holes through which the outer ends of the blades pass and are riveted.

Some special machinery, however, has been developed for use in making the channel-shaped bases. Fig. 2 shows a duplex milling machine provided with a very long table which serves as a fixture to hold two sections of square stock from which two backs are milled. As shown, a cut is about half finished in these pieces. The special table, the arrangement of the milling-machine head, cutters and the operation that is performed are so plainly shown in the illustration that further description is unnecessary.

Fig. 3 shows a special milling machine that has been developed from a cam-actuated profiler. At the rear a horizontal spindle has been provided, driven by bevel gears from the vertical shaft of the machine. A special table has been made of a length sufficient to accommodate one of the long channel-shaped strips. The feed of this table is by means of a pinion meshing with a rack as shown. The operation is milling a shallow, V-shaped groove in each side of the base piece into which stock from the wheels is caulked in order to fasten the blading into position. The illustration shows a cut partially finished on this special milling machine.

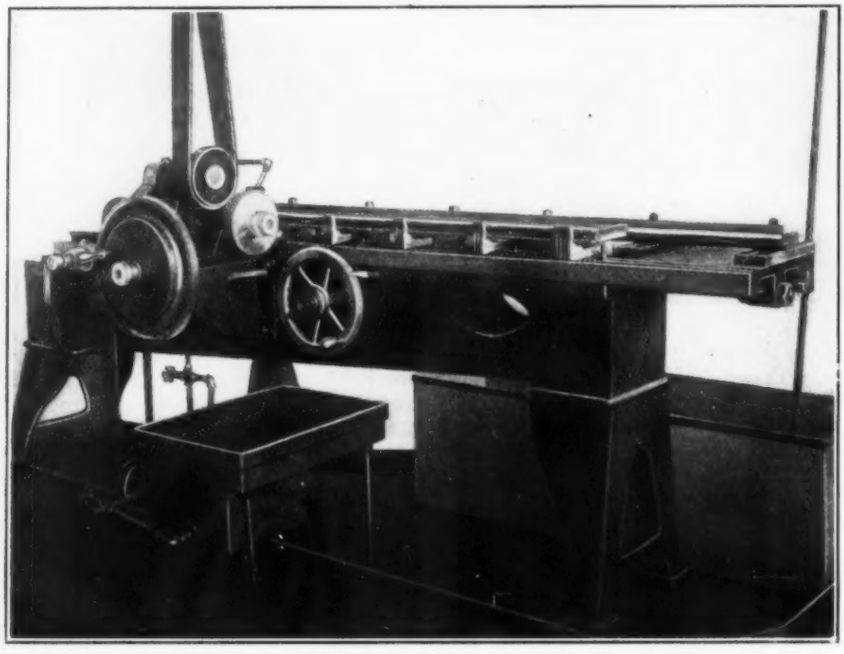


FIG. 4. SLITTING OPERATION ON BASE OF BLADES

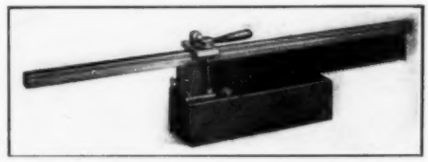


FIG. 5. RIVETING JACK FOR ASSEMBLING BLADES AND BASES

Turning now to Fig. 4 we see another special machine used for a multiple sawing operation in milling the slits that give the flexibility to the sections of blading. One of the difficult problems in milling a piece of this kind is to support it and clamp it so that the clamping devices will

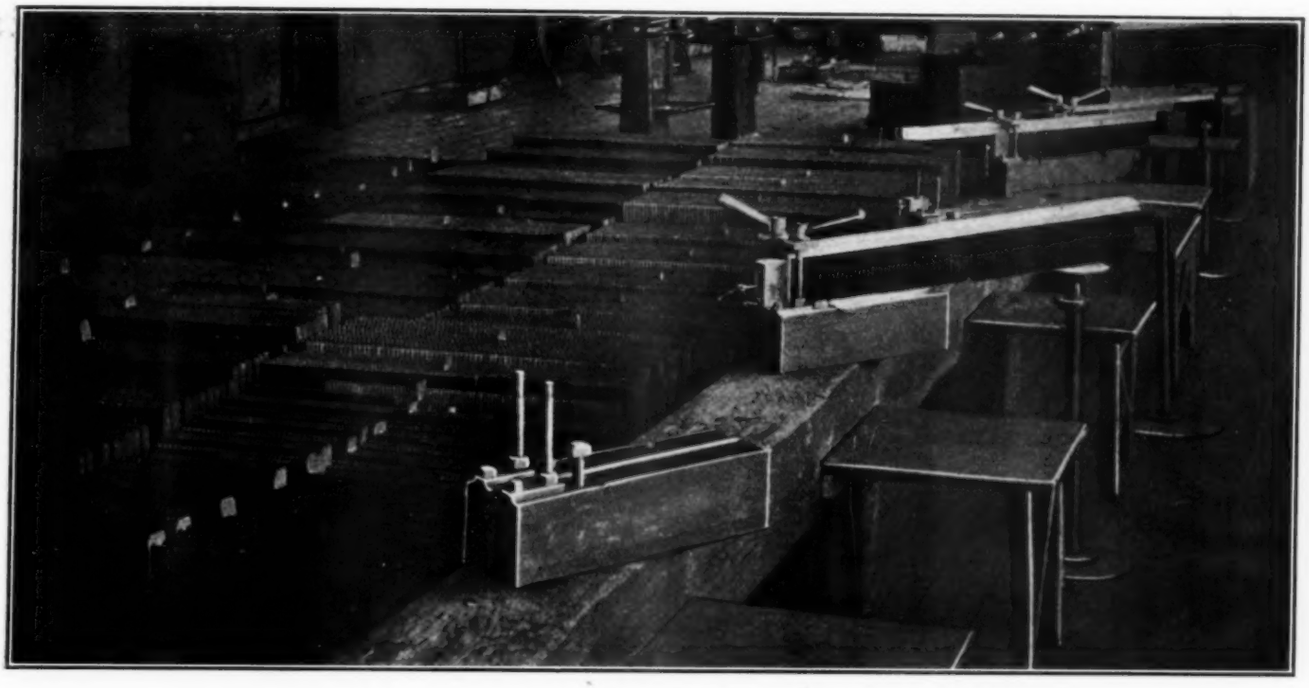


FIG. 6. A GROUP OF BLADE SECTIONS AND A ROW OF RIVETING JACKS

not be in the way, and yet rigidly and firmly hold the work. This problem has been ingeniously solved by a system of thin straps so spaced and located that they rigidly hold the piece in position in the fixture and at the same time allow the saws to pass between them and thus cut all of the slits without any resetting. This machine is provided with an automatic feed and stop. The mechanism is shown near the left-hand end of the illustration and consists of a large gear meshing with a pinion on the feed shaft. This pinion engages with the feed shaft by means of a simple jaw clutch. It has a face several times longer than the face of the gear with which it meshes, permitting an encircling collar to be used against which the edge of the rim of the gear rubs as it nears the end of the cut and in so doing pulls the jaw clutch from mesh and stops the feed. These saw cuts are milled after the blades have been riveted in place.

FIG. 7. CALKING THE BLADE SECTIONS INTO THE WHEELS

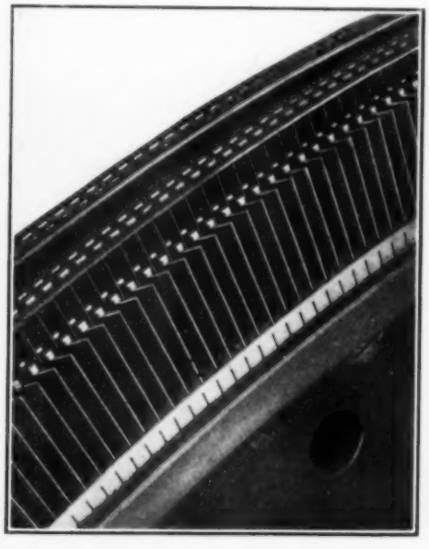


FIG. 8. SECTION OF WHEEL RIM AND BLADES

This riveting operation is done by hand

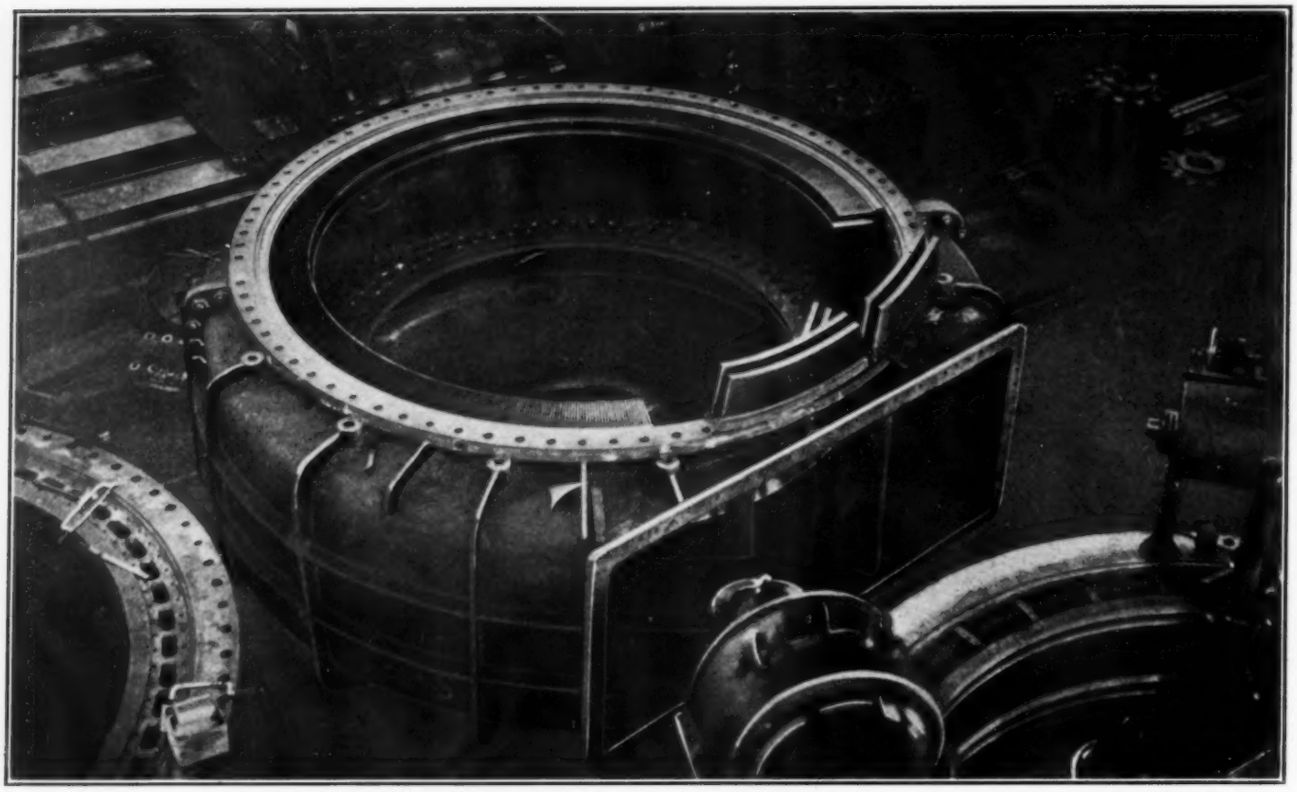
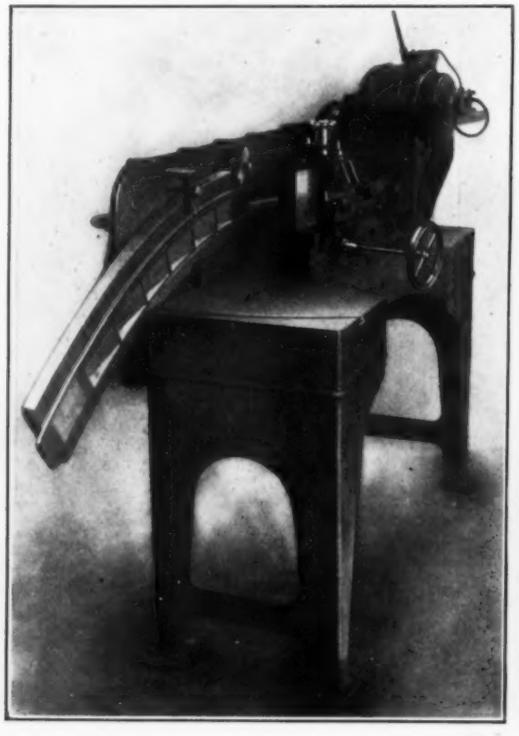


FIG. 9. AN EXHAUST SECTION OF THE TURBINE CASING, UNDERGOING ASSEMBLING

in a special riveting fixture, or riveting jack, shown in the illustration, Fig. 5. A block is provided with a clamping jaw so arranged that an individual blade will be grasped and held firmly in a vertical position; a strap clamp at the same time holds the base piece in its proper relation to this blade. When both blade and back are thus clamped in the proper relationship one to the other, the riveting is quickly and easily done. Various sizes of these jacks are necessary because of the many different lengths of the blades. This fact is illustrated by a glance at the bench shown in Fig. 6.

On the floor in this view can be seen a number of sections of many different lengths of blades, finished and ready for



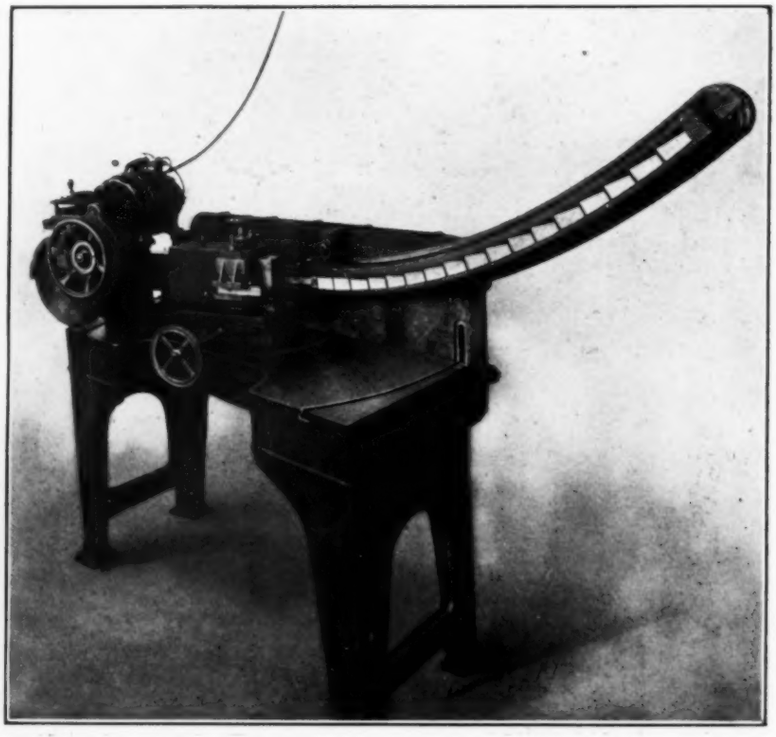


FIG. 10 TURBINE NOZZLE-PLANING MACHINE FIG. 11

assembling into the wheels and casings for the battleship turbines. All told, some 90,000 blades are required for both of the turbines. This view is taken at one end of one of the galleries of the machine shop; a particular section devoted entirely to the making of the blading.

Assembling the Blading in the Wheels

Fig. 7 shows one of the North Dakota turbine wheels mounted in a vertical position for the operation of staking the blading into place and attaching the shrouding. These wheels are built up of disks of boiler plates to which are riveted and screwed cast-steel rims. The size of these wheels can be appreciated when it is stated that they are 12 feet in diameter when finished. Some of these wheels carry four sections of blading, as shown in Fig. 7, but the larger part of them have only three sets, as shown in Fig. 8. In the cast-steel rim are turned a series of grooves of a size to receive the legs of the channel-shaped backing piece of the blading. These sections of the blading are properly placed in position and the steel rim is then staked or calked down into the V-shaped grooves milled in the sides of the channel legs; in this manner the blading is firmly held in position in the wheel.

Referring to Fig. 7, at about the right-hand end of the horizontal diameter can be seen a fixture, which is a pair of dovetailed blocks the upper one of which resembles a tool block of an English lathe. In this block is clamped a pneumatic hammer which has a forked calking tool that straddles the blades and stakes over the edges of the rim groove. Meanwhile the wheel is slowly rotated by power from the electric motor which is shown near the lower right-hand corner. At the same time the shrouding is strained into position over the milled outer ends of the blading and the ends of the blades are securely riveted over.

These details of construction show more plainly in Fig. 8 where a section of blading is in place in the rim, this rim having been staked down to hold it. The ends of one set of blades are shown without the shroud, another set with the shroud slipped over it and a third set with the shroud in place and the blade ends riveted over.

The exhaust section of one of these turbines can be seen in Fig. 9, with a portion of the intermediate blading of the last stage in position, and two of the remaining sections standing on the face of the flange. These blades are the same as those which have been described for the wheels except, of course, that they are set to converge instead of diverge with reference to the axis of the turbine. The various sections of blading are fitted into steel segments which, in turn, are bolted in place in the casing.

FIG. 12. TOOLS USED BY TURBINE NOZZLE-PLANING MACHINE

From this description it will be seen that the blades themselves and their method of manufacture, together with their component parts, are comparatively simple and that no difficult machining operations are involved. Tests that have been made show that a pull of some 9000 pounds is required in order to loosen a blade after it has been properly calked in position. This we are assured is more than ample to resist any strains to which a blade may be put in service.

Three Special Machine Tools

Three special and most interesting tools are illustrated by Figs. 10 to 16, inclusive. These are: A turbine nozzle planing machine, a turret circular rack-cutting machine, and a propeller planing machine.

The Turbine Nozzle Planing Machine

Figs. 10 and 11 show the turbine nozzle planing machine, and Fig. 12 the tools that it uses. These nozzles are long segmental-shaped, government bronze castings, in which a series of openings are cored. These openings have a double taper, that is, they are much larger in area on the outlet side of the nozzle than on the inlet. The reason for this is to give the steam a chance to expand into a continuous mass as it issues from the nozzle and passes to the turbine buckets. In order that this condition shall be properly fulfilled, these openings must be of an exact size and with smooth surfaces. The earlier method of production involved hard chipping and filing. This was an expensive process and the results were none too satisfactory. For that reason this special planing machine was designed and built.

As there are both right-hand and left-hand nozzles in a reversing turbine, it was necessary to build the machine to plane both kinds. To care for this feature the machine was devised with a swiveling head, which carries all of the operating parts, together with a motor, which is the source of power. This head can be used on either end of the machine and thus plane either a right-hand or a

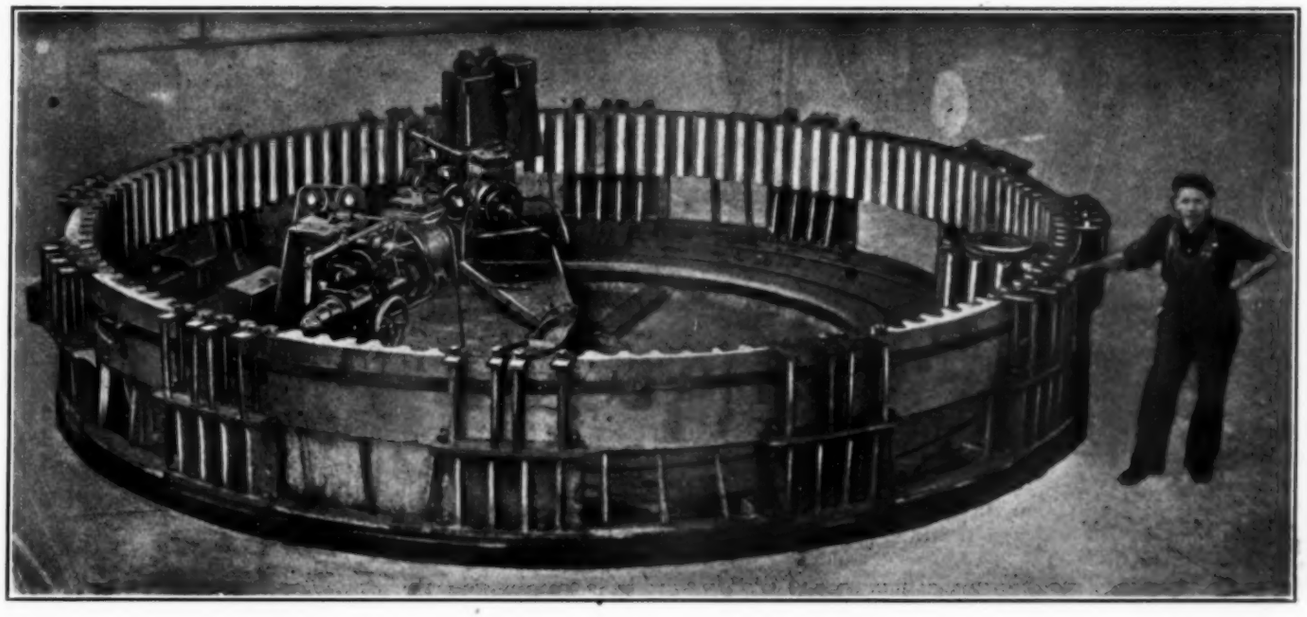


FIG. 13. CUTTING THE TEETH OF A TURRET CIRCULAR RACK

left-hand nozzle, as desired. At the same time it is possible to swivel the head for minor changes of adjustment in order to have the tool line up with either side of a given nozzle opening. This swiveling feature is plainly shown by the illustrations.

The head of the machine consists of a base casting, provided with suitable holding-down bolts that fit into circular slots in the bed of the machine, and carrying a saddle upon each side of which is a dovetailed slide fitted with a tool holder. This saddle is actuated by a crank, which in turn is driven to a system of gearing from a variable-speed motor. Two hand wheels are provided for the feed; the one feeding the block carrying the saddle in and out in a horizontal plane, and the other feeding the tool holder up and down in a vertical plane.

At the back of the machine is provided a vertical table with suitable supports and straps to hold the nozzle castings. In both of the illustrations, Figs. 10 and 11, a casting is shown in position for the planing operation. The cored opening is quite narrow at its smaller end. For that reason the tools are made with serrated cutting edges, so that a minimum amount of feed travel will suffice to finish the surfaces being machined. The tools are illustrated in Fig. 12, where the lower is for roughing and the upper for finishing.

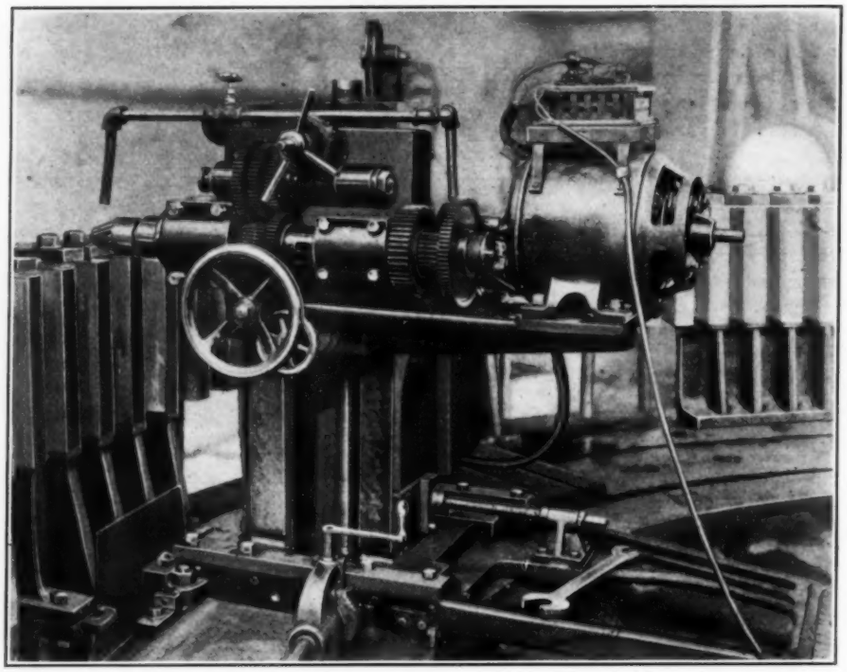


FIG. 14. ONE OF THE MILLING MACHINES OF THE CIRCULAR RACK CUTTER

Turret Rack Milling Machine

A battleship turret circular rack in the operation of cutting the teeth is illustrated by Figs. 13 and 14. At the left, in Fig. 13, can be seen the pinion that meshes with this rack. The face of the rack is some 18 inches long and the pitch of the

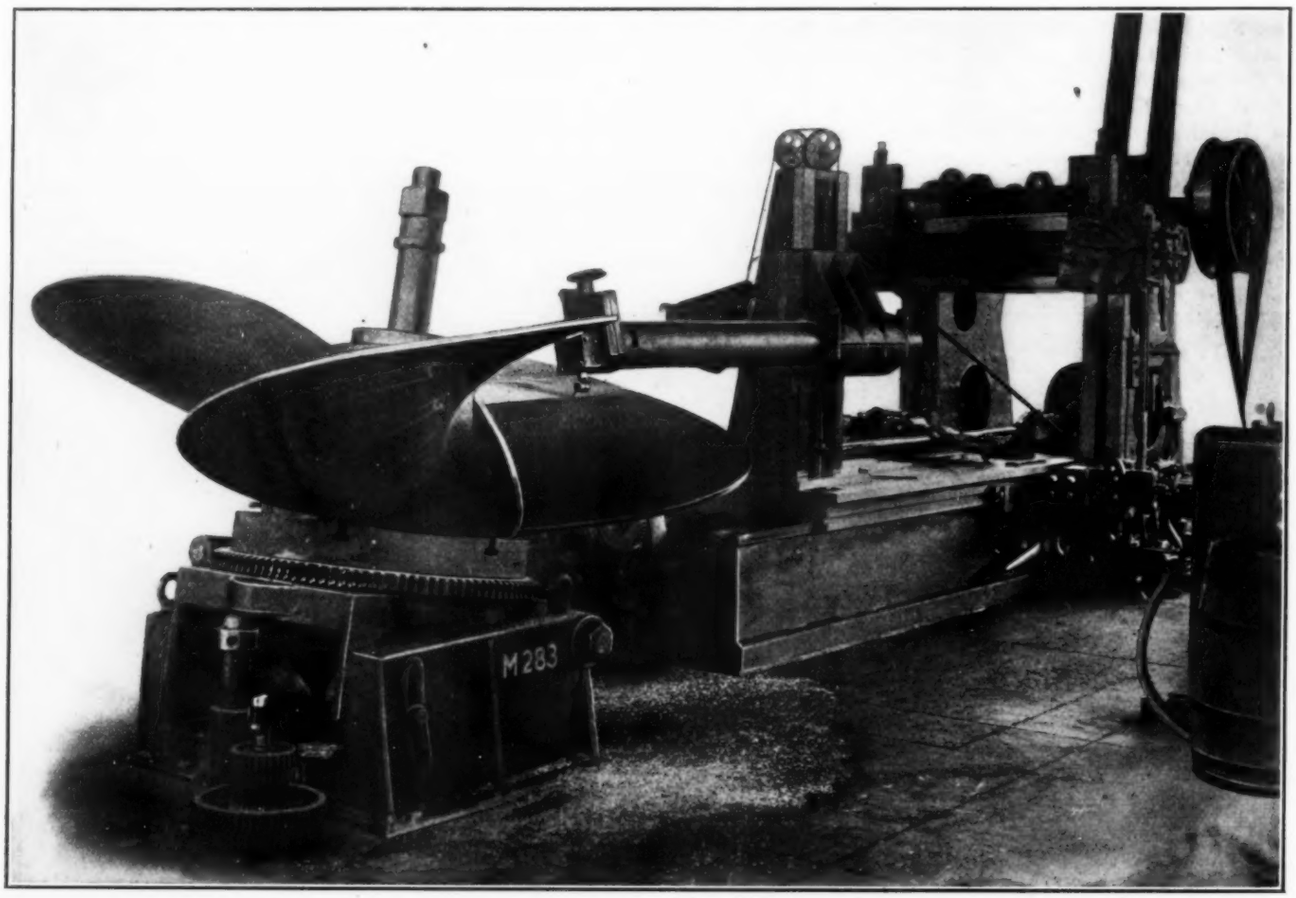


FIG. 15. A PROPELLER PLANING MACHINE

teeth is about 7 inches circular pitch.

The construction of the machine consists of a large circular bed plate provided with suitable T-slots for bolting down the supports for the rack and for two portable milling machines. Pivoted at the center of this circular bed plate are two swinging base plates, each one of which carries a complete portable milling machine arranged with a vertical feed in order to take a vertical cut. The rack is made of steel castings and is supported on a series of brackets built up from the main bed plate. The method of clamping the rack in position is plainly shown. In Fig. 14 the details of the milling machine are more prominent. Like most of the machines at this shipyard, it is a unit in itself; that is, it is provided with its own variable-speed, driving motor.

The cutting tool that is used is an end mill (see Fig. 14). The spacing of the teeth, or the dividing of the circular rack, is by means of the well known tape process. An interesting point in connection with lubrication lies in the fact that one of the circular T-slots is filled with oil, and thus forms a continuous oil reservoir from which lubricant can be taken for either of the milling machines in whatever position it may be.

A Propeller Planing Machine

From time to time we have illustrated in these columns various machines built for the purpose of planing marine propellers. The one here illustrated by the half-tone, Fig. 15, and the line engraving, Fig. 16, is perhaps one of the most successful that we have ever shown. The principle involved does not differ from others that have been built, but its application is different. Often a very large planer is used, and the propeller is mounted on it.

Here, although the operation is distinctly one of planing, a small planer is brought into service. Thus, a large and expensive tool is not tied up for the somewhat tedious operations of planing the blades of a propeller.

The propeller itself is mounted upon a holder, which has an independent foundation at the end of the planer bed. It is provided with a heavy shaft and rotating table. This table is arranged so that it can be tilted to allow for whatever aft rake is desired in the finished propeller. The table can be rotated in any inclined position by means of a worm and worm wheel.

Upon the end of the planer platen is mounted a vertical support for a saddle, which in turn carries a large bar similar to a boring bar. On the end of this bar is a head for the cutting tool. The saddle is arranged with a vertical feed driven through a system of gearing at the base. The feed for both the vertical motion of the bar and the simultaneous rotation of the propeller casting is derived from a shaft which runs the length of the planer table and is supported in independent bearings. The gearing and universal joints by which motion is taken from this shaft to the propeller holder can be better seen by referring to the line engraving, Fig. 16. On the rear of the planer platen are a motor and a cam. The motor is used for providing feed when turning the groove near the hub of the propeller, in which the planer tool reverses during the planing operation. When turning this groove, the planer platen is stopped, the cutting tool is lowered by means of the regular feeding mechanism of its bar saddle and the propeller is rotated in the usual manner. By this means a groove is turned near the hub.

When planing the surface of the blade the motor, however, is not used, but the feed is taken from the ratchet which is held in a bracket fastened to one of the vertical saddles of the planer. As the planer operates, the cam referred to raises and lowers this ratchet and thus produces the necessary feed motion. The change gearing at the end of the planer bed allows for the adapting of the machine to propellers of various pitches.

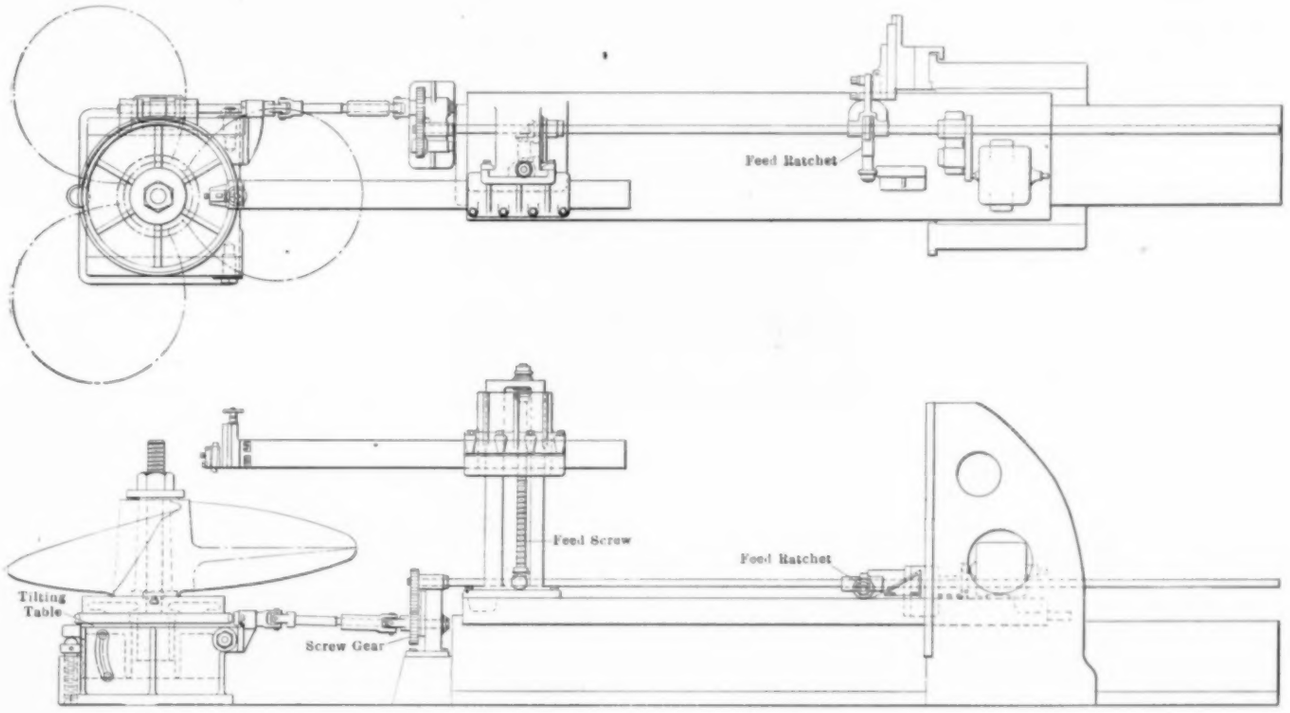


FIG. 16. DIAGRAMMATIC ASSEMBLY VIEW OF PROPELLER PLANING MACHINE

Among the interesting fuel tests which have been carried on during the past few years by the United States Geological Survey was a series of trials of low-grade fuels in gas producers. These tests indicated that many fuels of such low grade as to be practically valueless for use in boiler furnaces, including slack coal, bone coal, and lignite, may be economically converted into producer gas, and may thus generate sufficient power to render them of high commercial value. Coal containing as much as 45 per cent. ash, and lignites and peats high in moisture, were successfully converted into producer gas, which was used to drive gas engines.

Machining the Knee of a Cutter Grinder

The Cross Slide Bearing Surfaces on the Knee and the Bearing for the Column Are Finished with Special Fixtures and Cutters

BY A. J. BAKER*

The knee of a cutter grinder calls for a high degree of workmanship and must be more accurately machined than is necessary with many other machine-tool parts of approximately equal value. The bearing for the cross slide must be square in both planes with the column of the machine and as the accuracy of the grinder is largely dependent upon this point a description of the methods employed by the Cincinnati Milling Machine Company in machining the knee of their universal cutter grinder, may be of interest.

In Fig. 1, the knee is shown; *A* is the cylindrical bearing on the column; *B* the bearing for the cross slide.

Fig. 2 illustrates the fixture for the first operation, that of rough-milling the top and angles of the cross-slide bearing. This drawing also shows the details and Fig. 3 illustrates the cutters. It will be seen from the half-tone, Fig. 4, that this operation is performed on a vertical miller although the fixture is designed so that it can be used on a horizontal machine. It is hardly necessary to point out the greater ease with which the work can be handled on the former type of machine, or that the workman has the cutters in full view during the whole of the operation.

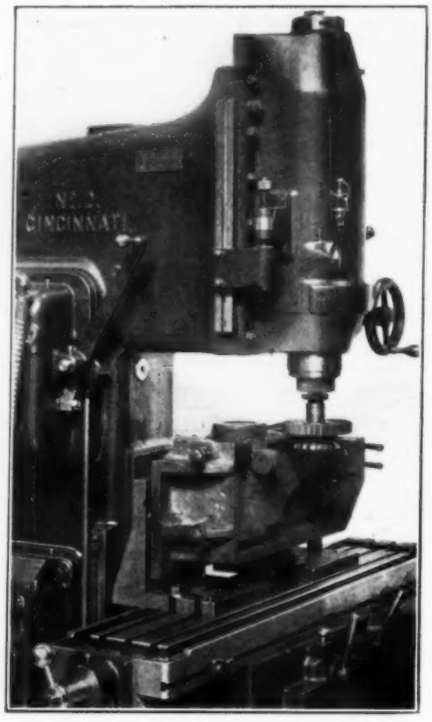


FIG. 4. MILLING THE DOVETAIL EDGE OF KNEE

The fixture itself consists of a main body to the right-hand end of which are fastened two V-blocks, locating the round part of the knee casting. These blocks are of machine steel, case-hardened and are milled away for the greater part of their width leaving only a narrow gripping surface which can bite into the work.

Opposite these gripping surfaces and carried in a rib projecting from the rear or base plate of the fixture, are two push pins *A*; these, moving outward under the influence of screws *B*, force the knee home into the V-blocks.

At the other end of the fixture are two support points *C*; of these the front one is fixed, that at the rear being adjusted to the work by the screw projecting from the end of the fixture acting on a bevel-end push pin. Above these points are two locking screws. An end stop *D* provides the remaining locating point.

In operation, the angular and plain milling cutters mounted on a short arbor mill one angle and one side of the cross-slide bearing with the table feeding from left to right. The saddle is then moved inward the required distance—reading from the cross-screw dial—and the re-

*Chief, tool-designing department, Cincinnati Milling Machine Company.

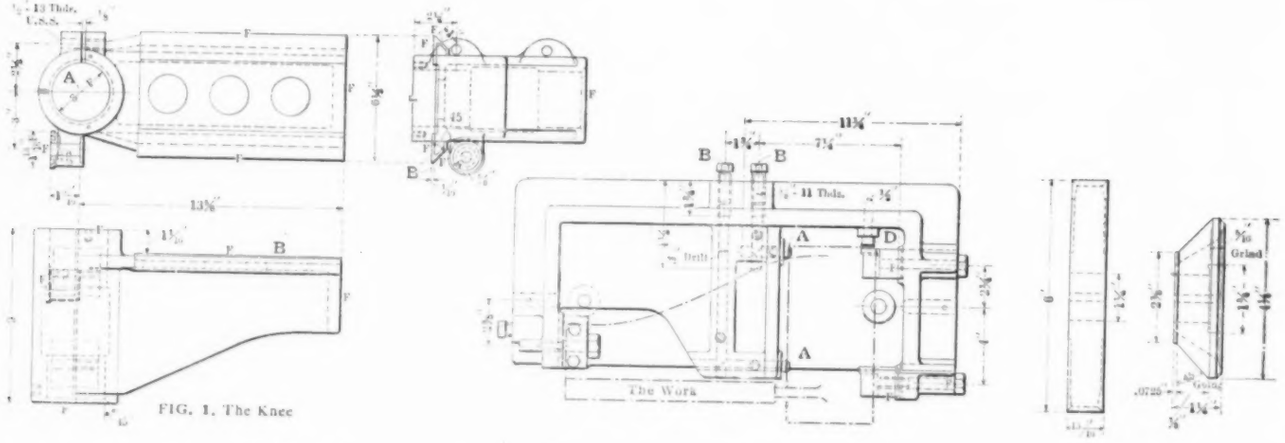


FIG. 1. The Knee

FIG. 3

FIG. 2. FIXTURE FOR FIRST, SECOND AND THIRD OPERATION ON KNEE

maining angle and face milled with the table feeding in the opposite direction.

The depth of cut in this operation varies from 3/16 to ¼ inch per face. Fast feeding resulted in shearing the key which drives the plain cutter. To overcome this difficulty, a tongue was ground on the face of the hub and a key fitted in the face of the arbor. Under these conditions a feed of 7 inches per minute is maintained.

The second operation is that of rough-milling the face at the top of the column bearing; for this the same fixture and machine are used as described, together with a plain 5-inch face mill.

At the third operation the face for the cross-slide bearing is finished, using the same machine, fixture and tools as per operation No. 2.

The fourth operation finishes the angular faces. Here again the vertical machine, together with the fixture shown in Fig. 5, is used, the cutter being a standard 1¼-inch end mill. The fixture has two main parts, a base plate and a swinging plate. This latter revolves through 90 degrees on a shaft carried in the uprights of the base. It is locked in its two positions by the pivoted clamp bolts carried in the ears projecting from the sides of the base. On either side of and as close as possible to the slots in the swinging plates in which the clamp bolts are located, are two adjustable screws which, resting on hardened-steel points in the base plate, form the stop, a resting place for the swinging plate. These screws are set to give the locating plate an inclination of 45 degrees to the base of the fixture, or the milling-machine table. When the screws have been set, other small locking screws of the same size are set down onto their heads; and further to prevent any accidental or intended adjustment going unseen, the remaining space is filled with melted lead. The knee is located in the fixture against an end stop *A* and also against two disappearing stops *B*. These are disks, having a flat milled on their periphery, carried on two studs which revolve in the swinging plate. When the work has been located and clamped, the studs are turned, bringing the flat on the disk below the locating surface of the fixture and consequently out of reach of the cutter.

FIG. 6. FINISHING THE DOVETAIL

The knee is secured to the fixture with two special clamps, which are keyed to prevent turning under the nuts, and carry at their extremities hardened-steel points which clamp the work as nearly as possible directly over that surface machined in operation No. 3. This is, of course, done in order that the clamping shall not spring the work. A steel plug *C* with hardened end carried at one end of the fixture furnishes a setting piece for the cutter. Fig. 6 illustrates the fixture and work passing under the cutter.

The fifth operation is that of milling the front of the knee. For this the knee is mounted on an angle bracket carried on the table of a horizontal milling machine. This bracket presents the front of

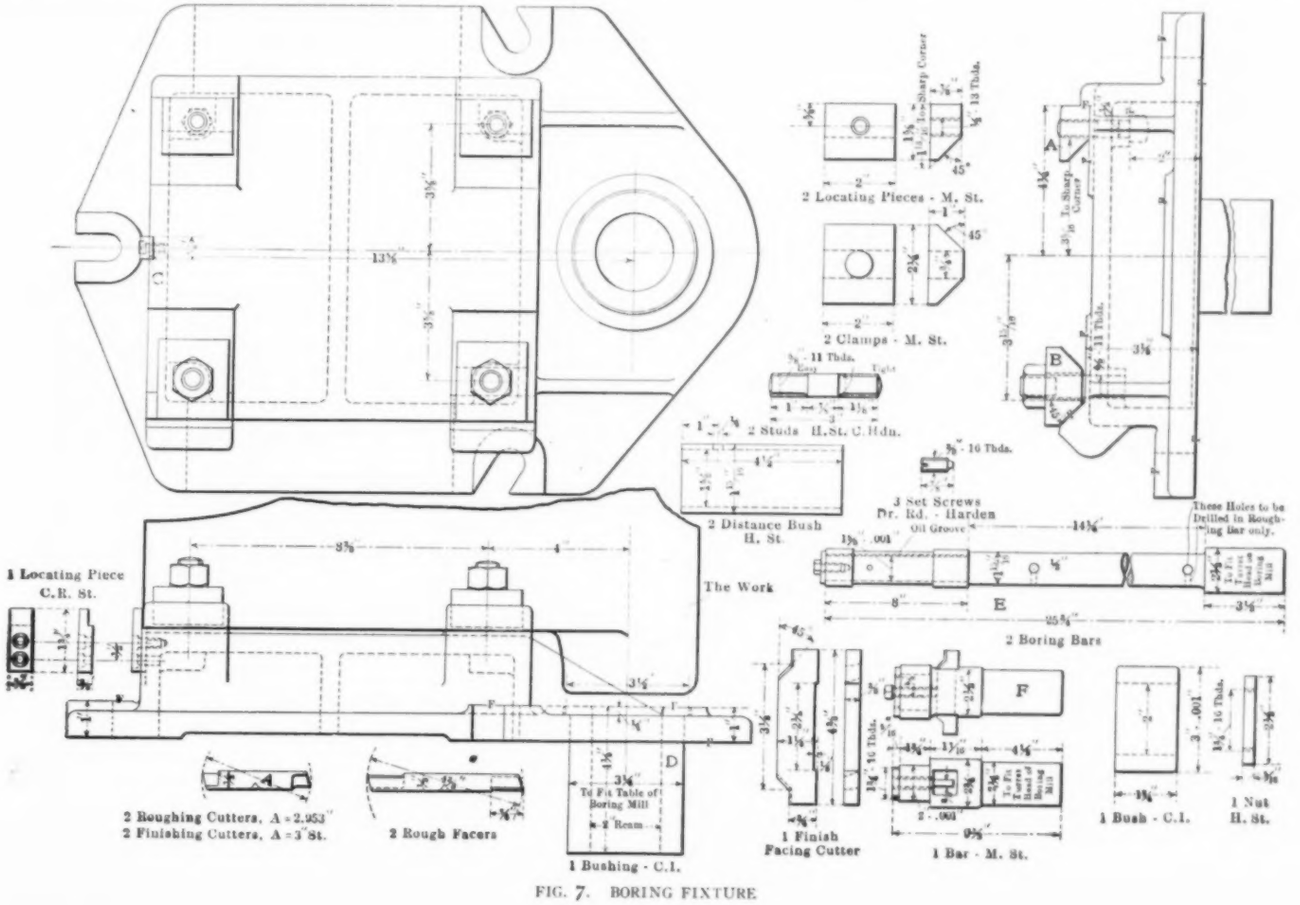

2 Locating Pieces - M. St.
2 Clamps - M. St.
2 Studs H. St. C. Hdn.
3 Set Screws
Dr. Rd. - Harden
2 Distance Bush
H. St.
The Work
1 Locating Piece
C.R. St.
2 Boring Bars
These Holes to be Drilled in Roughing Bar only.
2 Roughing Cutters, A = 2.953"
2 Finishing Cutters, A = 3" St.
2 Rough Facers
1 Bushing - C.I.
1 Finish Facing Cutter
1 Bar - M. St.
1 Bush - C.I.
1 Nut
H. St.

FIG. 7. BORING FIXTURE

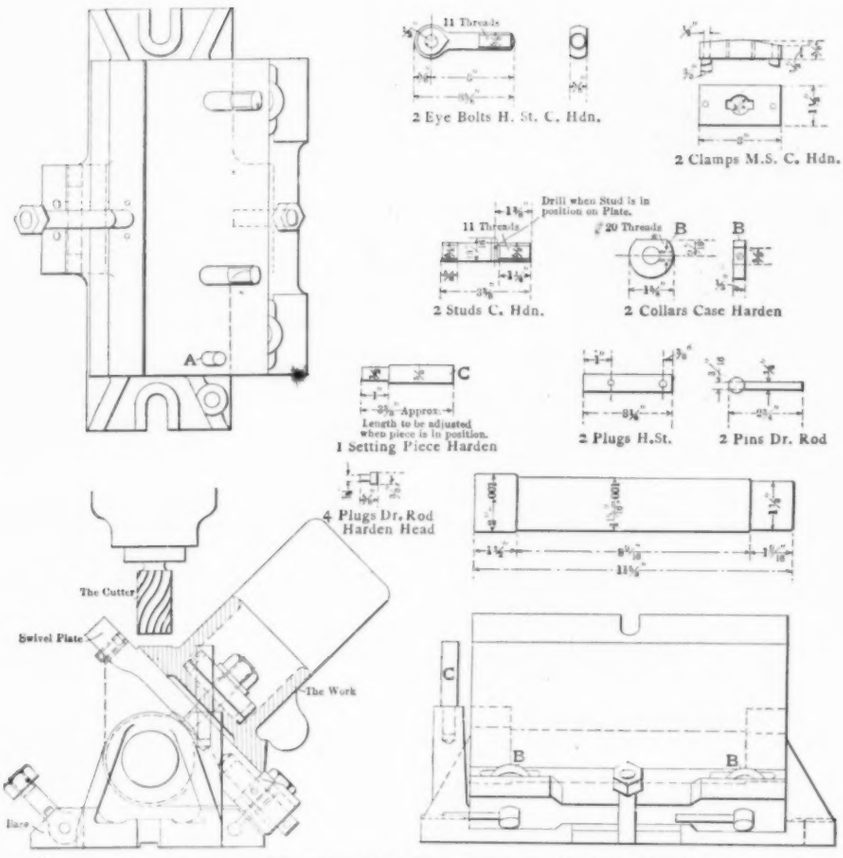


FIG. 5. FIXTURE FOR FINISHING BEVELED FACES OF DOVETAIL

the knee to the cutter, a 6-inch face mill. Two such brackets are used, one of which is filled while the other is operated on. Sawing the slot for the clamp bolts at each end of the column bearing is the next operation. For this a similar pair of angle brackets as per operation No. 5 is used. The seventh operation is that of drilling and tapping the clamp-bolt holes; no special tools are required in this case.

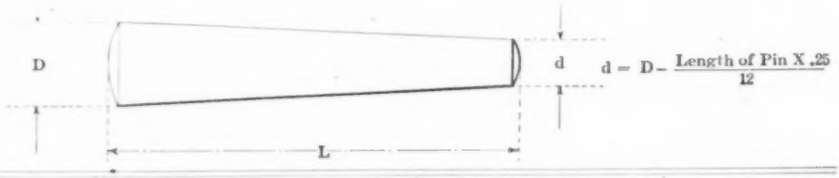
Fig. 7 shows the fixture for the eighth operation of boring the hole and finish-facing and leveling the boss after the cross-slide has been rough-scraped. This fixture, carried on the boring-mill table, locates the knee by the completed cross-slide bearing resting upon its upper surface against the stop *A* and secured by the clamps *B*. An end stop *C* locates the boss in the correct position. A cast-iron bush *D* fits in both fixture and boring-mill table, thus locating the fixture centrally with the table and providing a guide for the boring bar. This bar *E* carries two revolving bushes, which fitting in bush *D*, guide the bar at the boring of the upper and lower portions of the column bearing. The counterboring tool used in this operation is shown at *F*; it has a revolving bush and flat formed cutter.

The remaining operations consist of drilling and tapping various small holes in the knee and are of hardly sufficient interest to warrant description. The cross-slide bearing when finished as described should be square within a limit of 0.0015, testing from both ends of a 24-inch square. It is very seldom that an error of more than 0.001 is found.

Drill Sizes for Taper Pins

By C. T. Schaefer

The accompanying table gives the drill sizes for taper pins ranging in lengths by ¼ inch from No. 0, ¾ inch long, to No. 10, 6 inches long. The diameter of the small end of the pin for each length is given in the fourth column of the table with the corresponding drill size in the fifth column. I have found this table a great convenience in my work, and trust it may be of service to others.



Number of Pin.	L	D	d	Number of Drill.	Number of Pin.	L	D	d	Number of Drill.	Number of Pin.	L	D	d	Number of Drill.
0	¾″	0.156″	0.1404″	28	6	2½″	341″	0.2941″	19/64″	9	2 ″	0.591″	0.5493	35/64″
0	1 ″	0.156″	0.1352″	29	6	2¾″	341″	0.2889″	9/32″	9	2¼″	0.591″	0.5441	35/64″
1	¾″	0.172″	0.1564″	22	6	2¾″	341″	0.2837″	9/32″	9	2½″	0.591″	0.5389	17/32″
1	1 ″	0.172″	0.1512″	24	6	3 ″	341″	0.2785″	9/32″	9	2¾″	0.591″	0.5337	17/32″
1	1¼″	0.172″	0.146 ″	26	6	3¼″	341″	0.2733″	9/32″	9	3 ″	0.591″	0.5285	17/32″
2	¾″	0.193″	0.1774″	16	7	1 ″	0.409″	0.3881″	25/64″	9	3¼″	0.591″	0.5233	33/64″
2	1 ″	0.193″	0.1722″	17	7	1¼″	0.409″	0.3829″	25/64″	9	3½″	0.591″	0.5181	33/64″
2	1¼″	0.193″	0.167 ″	18	7	1½″	0.409″	0.3777″	25/64″	9	3¾″	0.591″	0.5129	33/64″
2	1½″	0.193″	0.1618″	20	7	1¾″	0.409″	0.3725″	25/64″	9	4 ″	0.591″	0.5077	33/64″
3	¾″	0.219″	0.2034″	6	7	2 ″	0.409″	0.3673″	3/8″	9	4¼″	0.591″	0.5025	1/2″
3	1 ″	0.219″	0.1982″	8	7	2¼″	0.409″	0.3621″	23/64″	9	4½″	0.591″	0.4972	1/2″
3	1¼″	0.219″	0.193 ″	10	7	2½″	0.409″	0.3569″	23/64″	9	4¾″	0.591″	0.4929	1/2″
3	1½″	0.219″	0.1878″	12	7	2¾″	0.409″	0.3517″	23/64″	9	5 ″	0.591″	0.4868	31/64″
3	1¾″	0.219″	0.1825″	14	7	3 ″	0.409″	0.3465″	11/32″	9	5¼″	0.591″	0.4816	31/64″
4	¾″	0.250″	0.2344″	13/64″	7	3¼″	0.409″	0.3413″	11/32″	9	5½″	0.591″	0.4764	31/64″
4	1 ″	0.250″	0.2292″	13/64″	7	3½″	0.409″	0.3361″	11/32″	10	1¼″	.706″	0.6747	43/64″
4	1¼″	0.250″	0.224 ″	1	7	3¾″	0.409″	0.3309″	11/32″	10	1½″	.706″	0.6695	43/64″
4	1½″	0.250″	0.2187″	2	8	1¼″	0.492″	0.466 ″	15/32″	10	2 ″	.706″	0.6643	43/64″
4	1¾″	0.250″	0.2135″	3	8	1½″	0.492″	0.4608″	15/32″	10	2¼″	.706″	0.6591	21/32″
4	2 ″	0.250″	0.2083″	4	8	1¾″	0.492″	0.4555″	15/32″	10	2½″	.706″	0.6539	21/32″
5	¾″	0.289″	0.2734″	9/64″	8	2 ″	0.492″	0.4503″	15/32″	10	2¾″	.706″	0.6487	21/32″
5	1 ″	0.289″	0.2682″	9/64″	8	2¼″	0.492″	0.4451″	15/32″	10	3 ″	.706″	0.6435	41/64″
5	1¼″	0.289″	0.263 ″	9/64″	8	2½″	0.492″	0.4399″	15/32″	10	3¼″	.706″	0.6383	41/64″
5	1½″	0.289″	0.2577″	1/4″	8	2¾″	0.492″	0.4347″	15/32″	10	3½″	.706″	0.6331	41/64″
5	1¾″	0.289″	0.2525″	1/4″	8	3 ″	0.492″	0.4295″	15/32″	10	3¾″	.706″	0.6278	5/8″
5	2 ″	0.289″	0.2473″	1/4″	8	3¼″	0.492″	0.4243″	15/32″	10	4 ″	.706″	0.6226	5/8″
5	2¼″	0.289″	0.2421″	1/4″	8	3½″	0.492″	0.4191″	15/32″	10	4¼″	.706″	0.6174	5/8″
6	¾″	0.341″	0.3254″	21/64″	8	3¾″	0.492″	0.4139″	15/32″	10	4½″	.706″	0.6122	39/64″
6	1 ″	0.341″	0.3201″	21/64″	8	4 ″	0.492″	0.4087″	15/32″	10	4¾″	.706″	0.6078	39/64″
6	1¼″	0.341″	0.315 ″	21/64″	8	4¼″	0.492″	0.4035″	15/32″	10	5 ″	.706″	0.6018	39/64″
6	1½″	0.341″	0.310 ″	21/64″	8	4½″	0.492″	0.3982″	15/32″	10	5¼″	.706″	0.5966	19/32″
6	1¾″	0.341″	0.3045″	21/64″	9	1¼″	0.591″	0.5597″	9/16″	10	5½″	.706″	0.5914	19/32″
6	2 ″	0.341″	0.2994″	21/64″	9	1½″	0.591″	0.5545″	9/16″	10	5¾″	.706″	0.5862	19/32″
										10	6 ″	.706″	581	37/64″

TABLE OF DRILLS AND SIZES OF TAPER PINS.

Government Purchases of Files

By E. P. Reichhelm

We have received a letter—of which we inclose a copy—which for obvious reasons must be published without the signature of the writer. We think that it is in the interest of the United States Government, as well as in the promotion of American industries, that this letter be published, it being one which throws a strong light upon the manner in which the Government supplies itself with its necessary tools.

Under a rigid adherence to the principle of competitive bids, it is unavoidable that the supplies furnished the Government should be of the lowest grade. In making bids to supply the Government's institutions, in many instances we have found ourselves beaten, because the designation of the articles in the bid furnished us made it impossible to insert prices which could secure the order when compared with quotations for a much lower grade of goods.

Briefly stated, we would suggest—not only to the Government, but to large manufacturing corporations—that their purchases of small tools, at least, should be governed by rules embodying the following points:

1. All bids for small tools should be accompanied by samples.
2. The samples to be practically tested in the operating department where used.
3. Samples are not to be passed upon by the purchasing department.
4. That the award be made to the *best quality*, at a price warranted by better service of the tool as compared with competing tools of inferior quality.

Usually it would be found that by paying a little more for the best quality, the Government would not only save money, but would encourage the production of the best quality of goods, thus benefiting the industries of the whole country, instead of discouraging quality by awarding contracts to the lowest bidder for the lowest quality of goods.

If this was merely a matter affecting any personal interests of mine, I would not expect you to publish this letter, but it seems to be of importance, not only to the Government, but involving the question whether the Government should encourage or discourage the production of the best of everything required in its industrial departments.

Messrs. E. P. Reichhelm & Co.,

Dear Sirs:

Will you kindly send me figures on assorted shapes of small files for my private use? I work at a vise in the department of * * * in the * * *.

I must say that the files they serve out to us are simply damnable. They are crooked, warped, not cut to edges, corners, or ends; they glaze over, and are in many cases recut files, some of them having broken tines. No doubt they are files rejected by the maker's inspector, but are good enough to unload on Uncle Sam.

You say, does not the Government inspect them? Yes, they used to, but so many of them were rejected that the inspection stopped. Cannot you sell files to the * * * department?

Engineer and Machinist

P. S.—It would cost me my job if it was known how I condemn the Government files.

Power for Machine Tools

By Frank H. Neely

The more one studies F. W. Taylor's paper on the Art of Cutting Metals, the more one is impressed with the wonderful painstaking accuracy of all of his investigations and the marvelous amount of thought and work necessary to produce such results and conclusions.

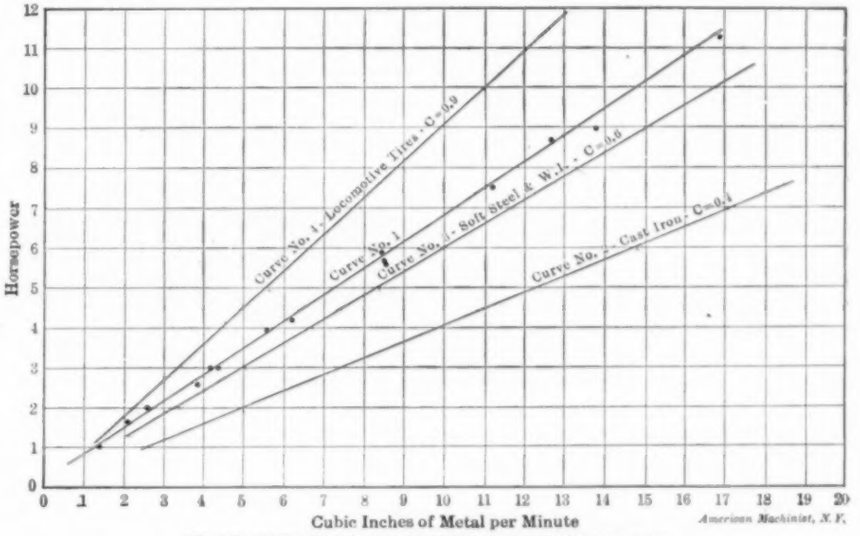

Horsepower
Cubic Inches of Metal per Minute
Curve No. 1 - Locomotive Tires - C=0.9
Curve No. 2
Curve No. 3 - Soft Steel & W.I. - C=0.6
Curve No. 4 - Cast Iron - C=0.4
American Machinist, N.Y.

CHART OF HORSEPOWER REQUIRED TO REMOVE METAL

Recently I desired to check up in some manner a series of tests, the object of which had been to ascertain the relation between the power to drive and the cubic inches of metal removed in rough-turning shafting. Not being able to find any such check directly in Mr. Taylor's paper, I hit upon the plan of figuring the power from his tables of the pressure on the tool for various cuts and feeds and speeds. Folder No. 14—1907 volume of the Transactions of the American Society of Mechanical Engineers—contains these figures, and it is there pointed out that the pressure on the tool is independent of the cutting speed and hence the power per cubic inch of metal removed will also be independent of the cutting speed. As a result of my estimations for the above I got curve 1, Fig. 1, which represents about the true average of the points plotted. Remarkable as it may seem this curve coincided exactly with the tests I first referred to.

This shows that long before the advent of the individual electric drive, painstaking investigators could arrive quite as accurately at the power required to cut metals as we now can in this day with our automatic recording devices—but of course, with no such ease and readiness.

In the American Machinist, page 91, Vol. 31, Part 1, Mr. Pomeroy has an interesting article on the power required for the individual drive of various machine tools and there gives the following formulas:

Horsepower to drive $= F \times D \times F.P.M. \times 12 \times N \times C$, where

F = feed in inches,
D = depth of cut in inches,
$F.P.M.$ = feet per minute,
N = number of cutting tools and
C = a constant with the following volumes, depending on the class of material:

Cast iron	0.35 to 0.5
Soft steel or wrought iron	0.45 to 0.7
Locomotive tires	0.7 to 1
Very hard steel	1 to 1.10

It will be seen from this that the expression ($F \times D \times F.P.M. \times 12$) is equivalent to cubic inches of metal per minute; therefore,

Horsepower = cubic inches per minute $\times C$, regarding N as one.

Now by taking the constant C for cast iron = 0.4; soft steel and wrought iron = 0.6 and locomotive tires = 0.9, he can plot the curves 2, 3 and 4 respectively for the horsepower per cubic inches of metal removed per minute. This agrees closely with curve No. 1 representing Mr. Taylor's results, as his steel was probably between wrought iron and locomotive tires in hardness.

A curve or set of curves made up from the horsepower required for lathes of given swing by various makers seems to come "all over the lot," so wide are the variations. Would it not be better for machine-tool makers to specify the power to drive their machines from the metal that can be removed per minute, rather than from the swing or other arbitrary methods?

Some Good Results Obtained by Adding Vanadium to Steel

EDITORIAL CORRESPONDENCE

Vanadium, when added to steel in the right proportion, improves it and the steel gives very good results for many purposes. This statement can no longer be questioned, as the numerous tests and experiments that have been carried on in the past few years have thoroughly demonstrated the fact.

One of the places where vanadium has proved itself to be an aid to steel is in the manufacture of high-speed steel, owing to its adding a property to the metal, that prolongs the life of the cutting edge. Some tests of this were recently completed at the Howard Axle Works in Homestead, Penn. The tests were made on a lathe which carried two cutting tools, and these were used for turning car axles to their proper shape and size.

One pair of high-speed-steel tools that contained vanadium machined 87 axles with one grinding, while the average of the high-speed steels that did not contain vanadium was 27 axles. Another pair of high-speed-steel tools that contained vanadium machined 1086 axles before they had to be redressed or reforged, while the average of the high-speed steels that did not contain vanadium was 300 axles. Under this test the tools were reground several times.

An idea of the amount of metal removed by this test can be obtained by a glance at Fig. 1. It took two of the long gondola cars to remove the chips, which would be one carload of chips and shavings that each tool removed before a new cutting edge had to be forged on it. As most of the high-speed steel manufacturers today add vanadium to their high-grade steels; this was, in reality, a test between the high-grade and low-grade tool steels.

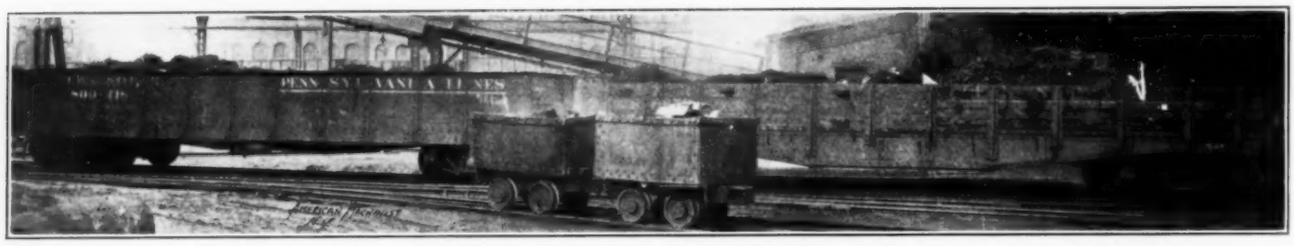


FIG. 1. CHIPS CUT FROM CAR AXLES WITH ONE PAIR OF HIGH-SPEED STEEL TOOLS CONTAINING VANADIUM

DIE STEELS

Steel that is made into die punches and die blocks has to stand almost continuous shock, strain and impact, and as vanadium adds to the ability of the steel to withstand these shocks and strains it adds to the life of the tools. Of course, steels with this ingredient must be heat-treated properly or the good results will not be obtained.

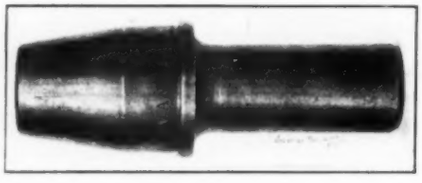


FIG. 2. VANADIUM STEEL PUNCH

FIG. 3. BROKEN PUNCH

Some good results on dies, similar to the one shown in Fig. 2, were obtained by the New York Shipbuilding Company, Camden, N. J., by the use of vanadium steel. Dies of this same style, made of tool steel, would last an average of 10 hours when used in a pneumatic hand machine for driving rivets. The dies were shaped for driving button-head, countersunk, and blind rivets. The breakage was almost invariably due to crystallization in the shank of the die, which in turn was due to the constant vibration. This can be seen in Fig. 3, which is a view of a broken die.

Dies made from different grades of tool steel, some of which cost as high as 17 cents per pound, were tried. These were a little better than the low-grade tool steel, but they did not last very much longer. Next vanadium steel was tried in the dies, and the first ones were made of a bar of Type K chrome vanadium steel, 3 inches in diameter. The first one of this lot of dies broke after being used for over 18 days, while three of them were in use for over 8 months. The last three dies have driven an average of 30,000 rivets and some of these were 7/8-inch rivets redriven cold against a large bottom riveter. This is one of the hardest tests for crystallization. The old tool-steel dies also showed considerable upsetting on the end, while the vanadium-steel dies showed practically none.

This has induced the company to try this steel for parts of pneumatic machines, such as pistons, bushings, etc., and they are also using it for expanding rollers. A vanadium-steel drilling machine has been tried and the stock to build 1000 more has been ordered.

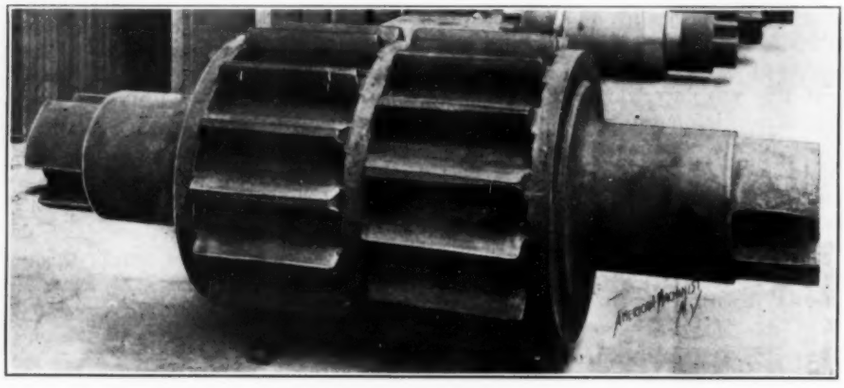


FIG. 4. CAST VANADIUM-STEEL MILL PINION

Hand Saws and Cast Pinions

The Union Saw Works, of Williamsport, Penn., has adopted vanadium steel for hand saws and circular saws which are made from a steel containing 0.95 per cent. carbon and 0.18 per cent. vanadium. One of the stunts which they do with their 26-inch, 12-tooth, hand saw is to roll it up into a roll about 8 inches in diameter, without its taking a permanent set. After this it is allowed to straighten out and is then used to saw through a 1-inch steel gas pipe. This shows that it is tough and well hardened, but at the same time it can be sharpened by filing, the same as the ordinary hand saw.

This company has also made some hack saws of this vanadium steel, for their own use only, which they claim will outlast more than two of the best saws they can buy, and these, when hardened for sawing metals, can be rolled up without breaking, until the ends pass each other. Another place where vanadium steel is giving some good results is in steel castings, and Fig. 4 is a typical example of one result obtained. This cast vanadium-steel mill pinion was made by the Mesta Machine Company, of West Homestead, Penn., which formerly cast them of a 3.5-per cent. nickel steel. It is 54 inches in diameter and weighs 33,660 pounds.

At the end of four months it had worn out one nickel-steel pinion, under very drastic mill service, and the photograph from which this cut was made was then taken. Another nickel-steel pinion was then put into companion mill service with this one and it wore that out before it gave out itself.

The Shearing Resistance of Mild Steel in Punching

By Y. Sekiguchi

In a punch press the resistance on the punch face increases as the punch presses into the plate, but there is a certain point at which the shearing resistance of the metal becomes a maximum. It is of great importance to a designing engineer to know the amount of maximum shearing resistance on the punch as well as the point where the force acts. As a preliminary investigation of the problem, the following tests were made on mild-steel plates:

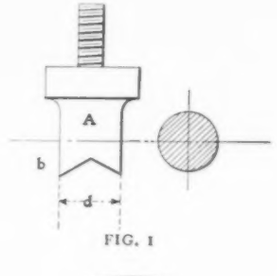


FIG. 1

FIG. 2

PUNCH AND PIECE PUNCHED OUT

The punch used in the test is shown in Fig. 1. It has a slight taper to relieve the friction when in contact with the inside of a hole being punched. The diameter of punch was calculated by Unwin's formula,

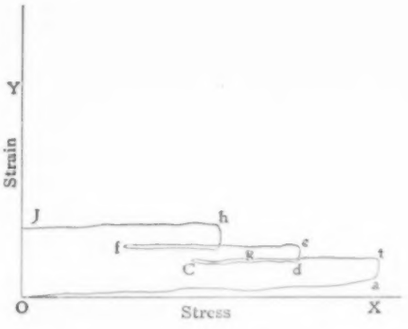


FIG. 3. STRESS-STRAIN DIAGRAM FOR PUNCHING MILD STEEL

$$d = 1.2\sqrt{t},$$

where d = diameter of punch in inches, and t = the thickness of the plate in inches. The tests were carried out in a 50-ton Buckton testing machine, and the load was applied gradually by hand power. Stress-strain curves were traced by the autographic apparatus of the machine.

Fig. 2 shows a shape of chip punched. On examining the surface of the chip, we notice a wave-like line around the circumference of the upper portion. This is due to the action of flow of metal and also, partly to a shearing component of compression before the plate begins to be punched.

Fig. 3 is a diagram actually taken from the machine. In the figure, OX, OY, represent, respectively, the shearing stress and the depth of impression in the plate. From O to a the load and the resistance increased almost proportionately, but at a the punch suddenly went down into the plate. At t the load was relieved gradually until it balanced with the resistance at C and again increasing the load from C to d the punch presses into the plate as before. By reducing the load e to f, the machine is balanced. Finally, the load is applied from f to h, and the plate punched through its entire thickness.

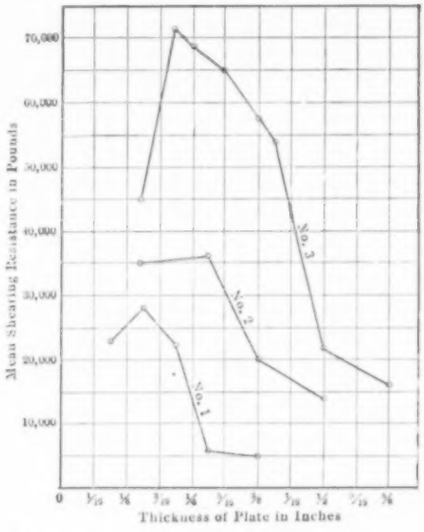


FIG. 4. RELATION BETWEEN SHEARING RESISTANCE AND PLATE THICKNESS

It is worth while to notice that the diagram shows two lines through C and f. Perhaps this is due to the elasticity of the metal compressed; that is to say, when the load is reduced the metal recovers its shape in a small amount. When the load is applied again the punch will press the chip to the depth along Cd or fg, as shown in the diagram.

1	2	3	4	5	6	7	8	9
No. of Test.	Date.	Thickness of Plate in Inches. (t).	Diameter of Punch in Inches. (d).	Depth of Impression in Inches. (S).	Maximum Resistance in Pounds. (P_1).	Minimum Resistance in Pounds. (P_2).	Mean Resistance in Pounds. $P_3 = \frac{P_1 + P_2}{2}$	Shearing Strength in Pounds per Sq. In. of Metal. $P_s = \frac{P_3}{\pi dt}$
1	June 19, 1908.....	1/16	0.734	1/32	46,590		23,295	
2			0.734	1/16	38,890	17,760	28,325	
3			0.734	3/32	31,700	12,700	22,200	
4			0.734	1/8	10,350	1,320	5,835	
5			0.734	5/32	10,350		5,175	53,900
6	June 11, 1908.....	1/8	0.848	1/32	70,340		35,170	
7			0.848	1/16	47,600	25,980	36,790	
8			0.848	3/32	29,590	10,710	20,150	
9			0.848	1/8	29,590		14,795	52,830
10	July 16, 1908.....	3/16	0.948	1/32	91,730		45,865	
11			0.948	1/16	84,900	58,020	71,460	
12			0.948	3/32	81,980	56,090	69,030	
13			0.948	1/8	78,060	52,060	65,060	
14			0.948	5/32	71,550	44,690	58,120	
15			0.948	3/16	66,770	41,350	54,060	
16			0.948	7/32	33,440	11,020	22,230	
17			0.948	1/4	33,440		16,720	49,420

TABLE 1. LOG OF PUNCHING TESTS OF MILD STEEL TO DETERMINE SHEARING RESISTANCE.

Table 1 shows the results of the tests.

Table 4 is a diagram of curves showing the relation between the shearing resistance and the thickness of the plates. If we write the results in figures we get:

No. of Plate.	Thickness of Plate in Inches. (t)	Point Where Maximum Resistance Occurs. (t_1)	Ratio of $\frac{t_1}{t}$
1	$\frac{1}{8}$	$\frac{1}{32}$	$\frac{1}{4}$
2	$\frac{3}{16}$	$\frac{3}{32}$	$\frac{6}{16}$
3	$\frac{1}{4}$	$\frac{8}{32}$	$\frac{1}{4}$

RESULTS PLOTTED IN FIG. 4 SHOWN IN TABULAR FORM.

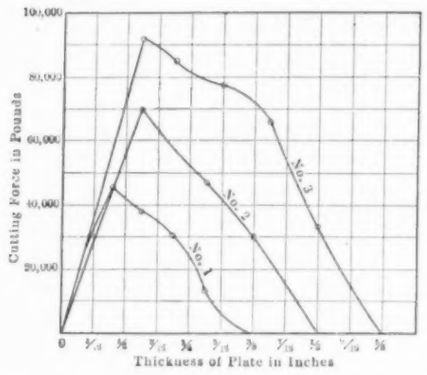


FIG. 5. RELATION BETWEEN MAIN SHEARING RESISTANCE AND PLATE THICKNESS

The above shows that the maximum shearing stress occurs when the punch has gone through about one-fourth of the total thickness of plate.

Fig. 5 shows the mean shearing resistance at successive parts of the plate during the punching action. From the diagram we get:

No. of Plate.	Thickness of Plate in Inches. (t).	Point Where Maximum Resistance Occurs. (k)	Ratio of $\frac{k}{t}$
1	$\frac{1}{8}$	$\frac{5}{32}$	0.417
2	$\frac{3}{16}$	$\frac{5}{32}$	0.562
3	$\frac{1}{4}$	$\frac{7}{32}$	0.350

RESULTS PLOTTED IN FIG. 5 SHOWN IN TABULAR FORM.

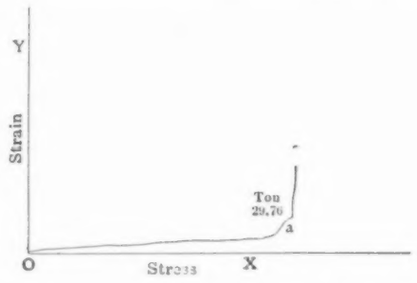


FIG. 6. STRESS-STRAIN DIAGRAM FOR RAPID PUNCHING

The maximum mean resistance acts on the punch face when it has proceeded through about 0.4 of the total thickness of the plate.

The tests were repeated by punching a plate at a high speed, and in this case the shearing stress reaches its maximum just before the metal punched. This is shown in Fig. 6.

350-Horsepower Silent Chain Drive

By C. M. Hamersly*

The Link-Belt Company has recently constructed at its Philadelphia plant three large silent-chain drives which are to transmit power for a wire-drawing bench at the plant of a large steel company.

Each drive is to transmit 350 horsepower at 10-foot centers, and, as shown in Fig. 1, consists of a wide-faced pinion connected to two large flanged wheels by two strands of 2-inch pitch Renold silent chain, each strand having a width of 12 inches. The pinions are to be mounted on the armature shafts of motors making 300 revolutions per minute, giving a driven speed of the gears of 65 revolutions per minute. These pinions were made from forged steel, and are about 16½ inches in diameter, have 26 teeth, with a face of 27 inches, and with a hub one side 2

*Shop engineer, Link Belt Company.

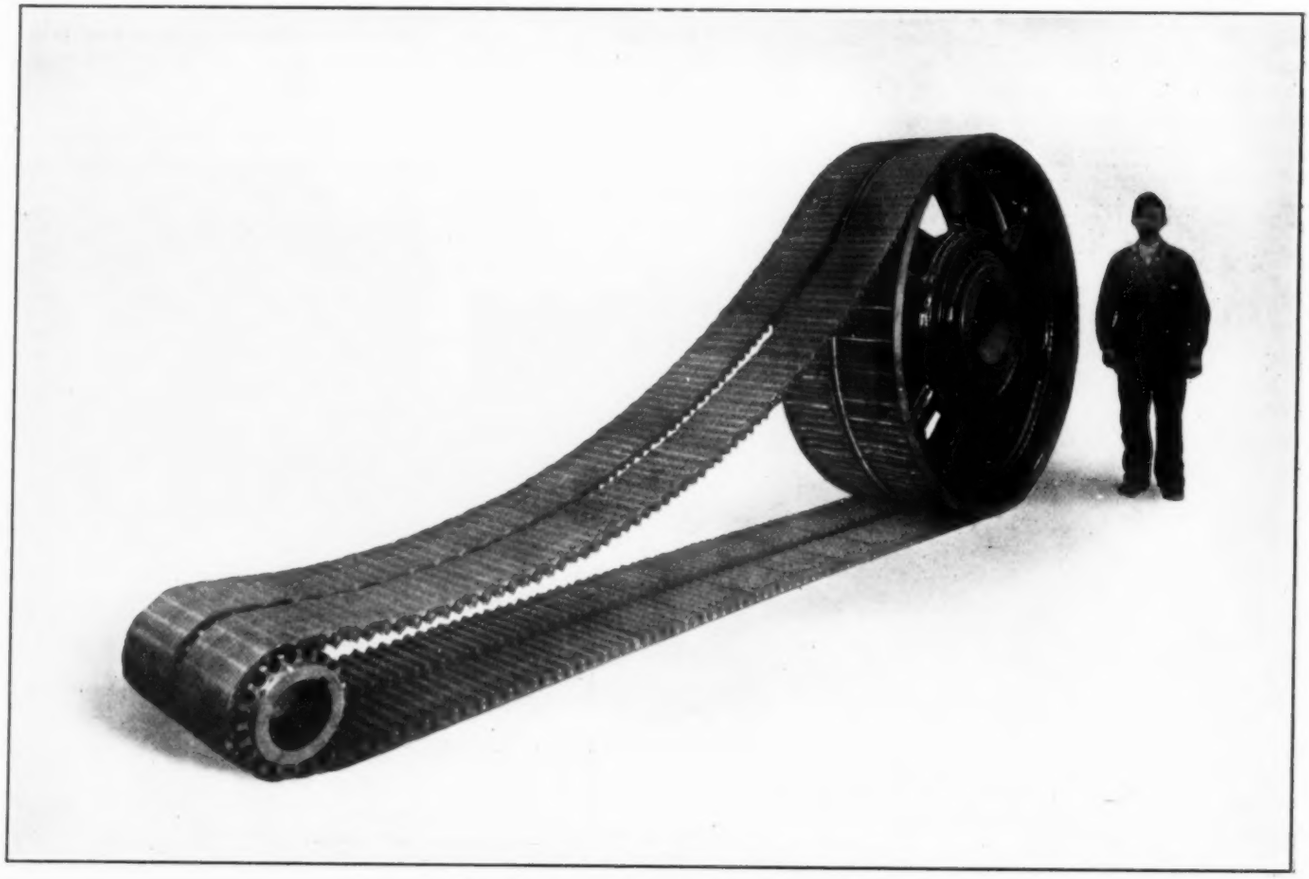
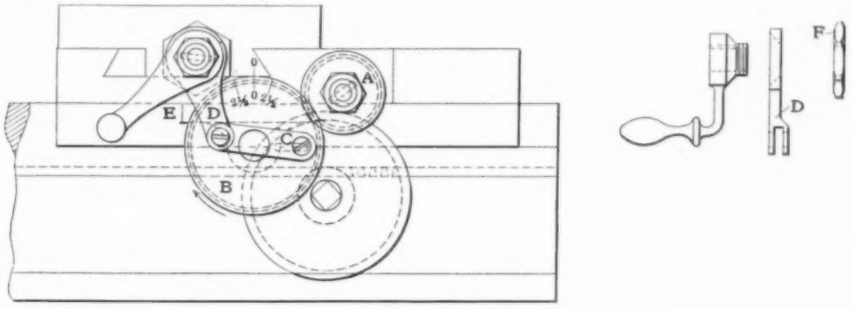


FIG. 1. 350-HORSEPOWER SILENT CHAIN DRIVE

inches wide by 14⅝ inches diameter. The bore is 10 inches, the total width through the bore 29 inches, the weight 850 pounds each.

The two wheels for each drive are mounted side by side. These wheels are made of cast iron, are about 76½ inches in diameter, have 120 teeth, with a face of 13½ inches, and each weighs 4200 pounds. Each wheel is provided with steel flanges and a special hub arranged with a spring-compensating device, as shown in Fig. 2. The object of this device is to provide an equalizing factor between the power shaft and the teeth of the wheel, so that any unevenness in the rotation of the power element and consequent shock will be absorbed by this device, permitting the power to be transmitted more evenly. Also if the device to which power is applied operates unevenly, then the equalizing device will absorb this shock and prevent it from being carried to the driving mechanism.

By absorbing shock this device also increases the life of the drive by preventing undue vibration which in time might tend to unduly wear the chain and the teeth of the wheels.



CROWNING PULLEYS ON THE ENGINE LATHE

Pulley Crowning on Engine Lathes

By E. W. Harris

In many shops where pulleys are turned in large quantities, the slow and laborious methods of crowning by hand are doubtless a great source of annoyance and perplexity, and any manufacturer who reserves certain of his lathes for pulley turning would be quickly alive to their enhanced value had they the additional power of crowning automatically. The line cut shows a fixture which surmounted the difficulty in one shop; it is especially adapted for the English engine lathe, and necessitated but very little alteration of the lathe to accommodate it.

Fig. 1 shows a portion of a lathe bed with carriage and automatic cross feed, the hand slide and tool post being omitted. The fixture consists of the wheels *A* and *B*, links *C* and *D*, *E* the cast-iron bracket carrying *B*, and the lock nut *F*. The gear wheel *A* is bored a working fit for the shaft, which operates the carriage traverse; the lock nut, which is usually of ample length, being thinned down to allow the wheel to be placed between it and the traverse pinion and so becoming locked with it when the nut is fastened. This wheel engages with the wheel *B*, which is located on the lathe by a small bracket *E* fixed to the underside of the saddle. *B* acts as a disk crank and moves the cross-feed screw of the compound rest to and fro by the links *C* and *D*. The link *D* is adapted to lock upon the cross-feed screw when at any position, the handle which operates this screw being cored off and threaded to receive a nut, as shown in Fig. 2, the nut locking the link and handle into a friction drive. A slot is cut in *B*, which allows the link *C* to be adjusted to or from the center for the purpose of shortening or lengthening the movement of the cross-feed screw when in operation; this results in a lesser or greater curvature of crown as desired.

The respective ratios of *A* and *B* are so arranged that with one revolution of *B* the saddle travels the limit of 3 inches, covering the widest pulley it is required to crown, and to insure the crown lying radially over the face of the pulley. The wheel *B* is set as indicated, and the uppermost tooth marked with a zero line, which coincides with a similar line upon the carriage; the wheel starting from this line and completing one revolution causes a saddle traverse of 3 inches.

For any pulley narrower than this the wheel *B* must perform only part of a revolution; for instance, in this case the third tooth on either side of the zero line is marked 2½ inches, the sixth 2 inches, and so on; it is only necessary to set the cutting tool in position, say, for turning a pulley of a 2¼-inch face, move the wheel until the left-hand tooth marked 2½ inches coincides with zero, fasten up nut *F* and the nut of saddle traverse; start up and revolve to the other 2½-inch tooth and a satisfactorily crowned pulley is the result.

In lathes having the cross-feed handles of the loose square-hole type a separate cone piece can be machined and fixed by shrinking, keying or other means upon the screw shank just beyond the squared end.

Leicester, England. E. W. H.

[In the United States shops turning out pulleys in large quantities use special pulley lathes, both cheaper and more efficient than doing the work on the engine lathe. E. W. H. has not taken care of the irregularities liable to result from (turning the cross-feed screw first in one direction and then back again) lost motion in the nut and cross-feed screw bearing.—Ed.]

FIG. 2. GEAR HUB WITH SPRING COMPENSATING DEVICE

The French mints are about to coin for the first time 25- and 10-*centime* pieces (fractional currency) made of aluminum to take the place of the old copper coins, which are to be withdrawn from currency.

Two Remarkable German Drilling Machines

Large Automatic, Motor-Driven Machines; One with Five Spindles for Boiler Shells, the Other with Six Spindles for Boiler Plates

SPECIAL CORRESPONDENCE

J. A. Maffei, Munich, Germany, has recently placed upon the market two drilling machines which are receiving special attention in the boiler-making field; first, because of the features of the designs and second, because of the reductions in cost of production that they are accomplishing. These two machine tools are a boiler-shell drilling machine and a boiler-plate drilling machine.

The Boiler-shell Drilling Machine

The boiler-shell drilling machine is illustrated by three half-tones, Figs. 1, 2 and 3. It is composed of two principal elements, the drilling machine proper and the attachment for holding and moving the boiler shell. The greater amount of time consumed in the drilling work on a boiler is in moving the work for the various settings, not in the actual time of drilling. The aim of this machine is to make the setting and moving of the boiler as short and simple an operation as possible.

Referring to the illustrations, it will be seen that the boiler shell is chucked on the ends and supported on trunnions. It is thus in a position to be rotated easily for all the various settings. The drilling machine proper is mounted on ways parallel with the length of the shell and can thus be moved in any position to reach any longitudinal or circumferential seam for which holes are to be drilled.

The most prominent advantages of the design, as stated by the maker, are:

A—The coincident drilling of five holes, horizontal and parallel for longitudinal riveting, or radial and circumferential for circumferential riveting.

B—The arrangement of a single drilling standard that can be manipulated by a single operator.

C—A revolving arrangement of a drilling head column, with automatic adjustment of the boiler for drilling both longitudinal and circumferential seams.

D—A holding attachment for the boiler shell, rapid in manipulation and rigid in use.

E—The automatic rotation of the work for setting in any required drilling position.

F—The automatic traverse of the drilling column in a direction parallel with the axis of the work.

G—The arrangement of operating levers and handles so that the starting, stopping, feed-changing and feed-varying of the machine are under the control of the operator without the necessity of his changing his position.

Considering details of the construction, all high-speed spindles run in bronze bearings. All gears which are under severe stress are made of steel or gun metal.

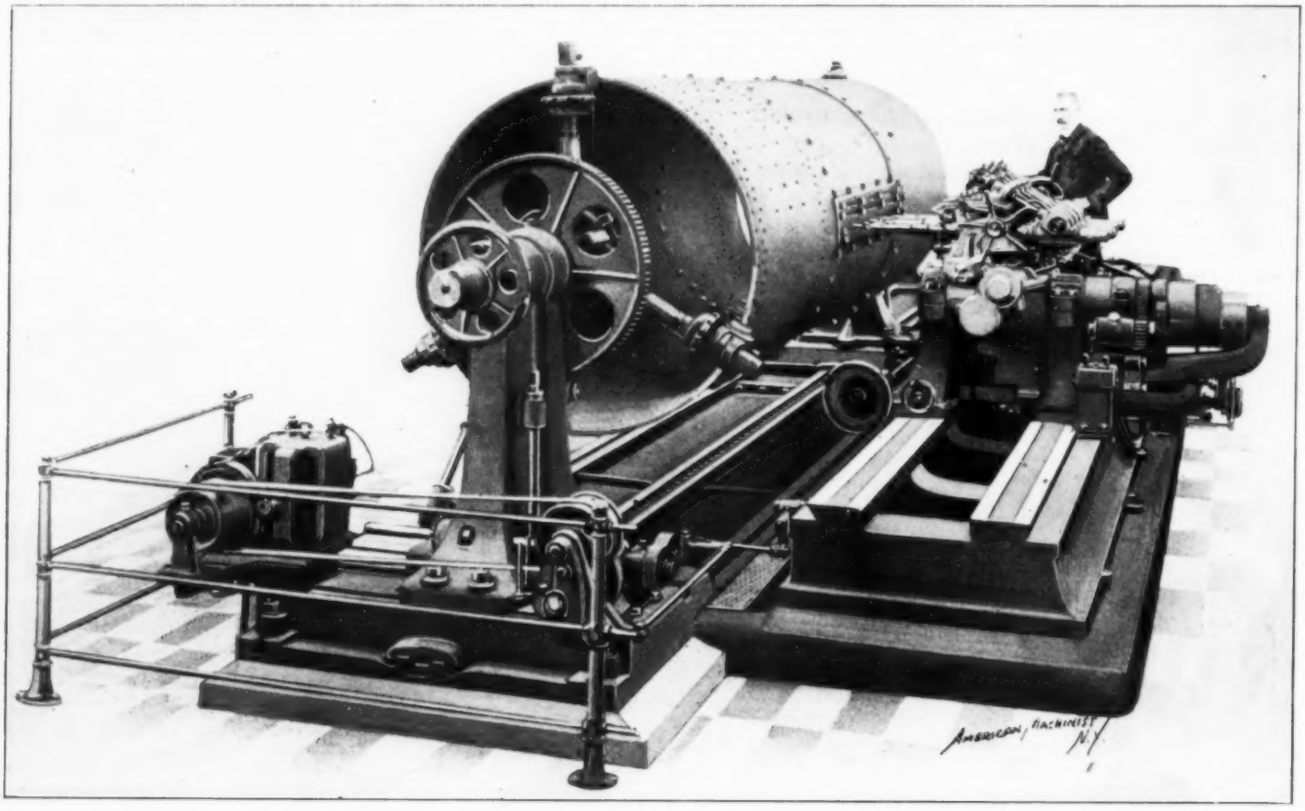


FIG. 1. GERMAN BOILER-SHELL DRILLING MACHINE AT WORK ON A HORIZONTAL SEAM

The quick-adjusting nuts for the racks of the drilling chucks are made of gun metal.

The feed of the drilling spindle is operated by means of a gear box which gives four changes of feed. There are also provided six cutting speeds, three of which are derived from the countershaft and the other three without the countershaft.

The work-holding device is composed of a large foundation plate or frame, on which are two adjustable and movable pedestals or supports resembling lathe tailstocks provided with chucks or holders. Each chuck is composed of a steel casting

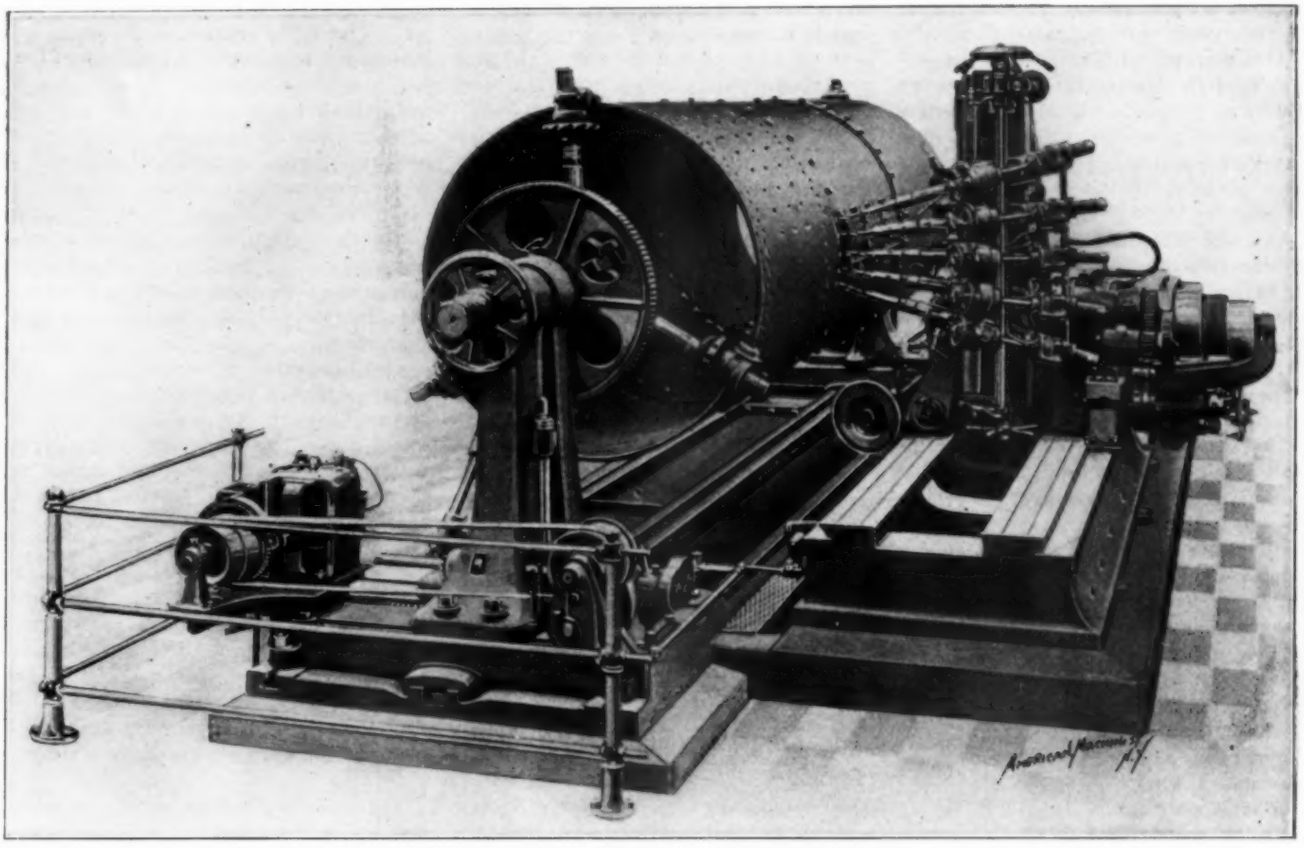


FIG. 2. GERMAN BOILER-SHELL DRILLING MACHINE AT WORK ON A CIRCUMFERENTIAL SEAM

fitted with a steel spindle and mounted on ball bearings to permit of easy rotation. Several speeds of rotation for the boiler are provided in order to adapt the machine to various boiler diameters and yet keep the peripheral velocity nearly constant. The drive for the drilling machine proper is from a 12-horsepower electric motor. Similarly the work-rotating

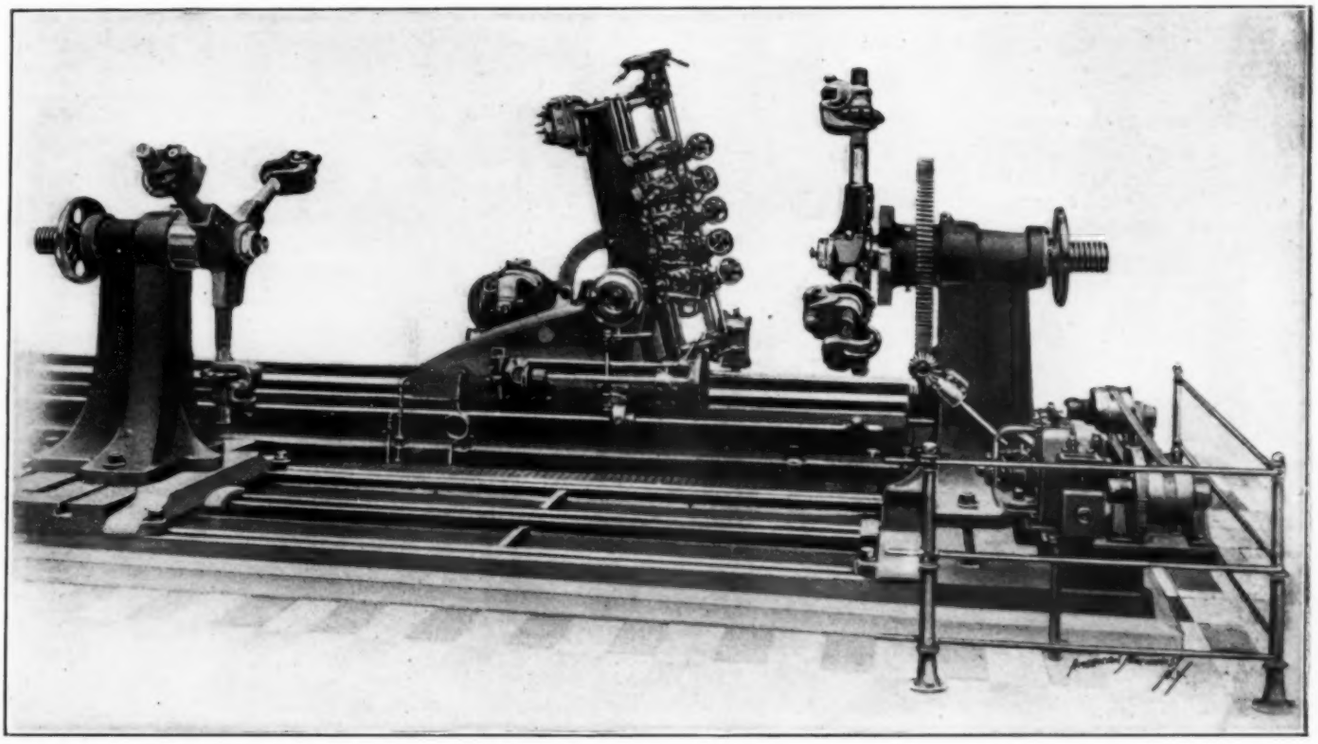


FIG. 3. ANOTHER VIEW OF THE GERMAN BOILER-SHELL DRILLING MACHINE—WITHOUT WORK

mechanism is driven by a 5-horsepower electric motor.

This type of machine is made in several sizes for boiler diameters up to 2.5 meters or 8 feet, and 9 meters in length or about 29 feet. The makers state that larger sizes will be built if required.

The Plate-drilling Machine

The second drilling machine, or plate-drilling machine is illustrated by Fig. 4. It has been designed to drill stay-bolt holes in fire-box plates and rows of holes in plates and other members used in the construction of locomotives, locomotive tenders, cars, bridges and the like. Its principal advantage is claimed to lie in the arrangement of the work. After the work has once been located in the machine, it is not moved during the drilling operation. One plate or several duplicate plates can be drilled at a time and thus the cumbersome handling, moving and adjusting of heavy pieces of work is done away with and, as in the case of the boiler-shell drilling machine, such operations often require more time than is consumed by the actual operation of drilling.

The entire machine can be moved longitudinally by automatic mechanism. One end runs on a track in the floor, the other end is supported on a heavy girder attached to the wall. The supporting rolls for both ends are provided with ball bearings to reduce friction.

It will be noted that the frames and legs are riveted and bolted structural-steel shapes and plates.

The revolving drilling head is carried on ball bearings and is self-acting as regards its traverse in both directions. All of the controlling levers and handles can be reached by the operator from a single position. The six spindles are balanced and are adjustable either individually or collectively. The lever for disengaging the feed operates on all six spindles simultaneously. For these spindles there are six cutting speeds, three with and three without back gears.

The drive of the machine is from an electric motor of 12 horsepower capacity.

The machine shown in the illustration can operate on plates up to 7000 millimeters in length by 3700 millimeters in width or about 280 inches by 148 inches. That is to say, the spindles can operate at any point over a working surface of about 275 square feet.

The Largest Column in the World

The following account of the largest column in the world is taken from the Boston *Mechanic* published in 1835. It was erected by Nicholas, Emperor of Russia, to the memory of his brother, the late Emperor Alexander:

The shaft was placed on its pedestal on St. Alexander Nefsky's day (August 30, old style, 1832,) in presence of the imperial family, nobility, citizens and strangers. The day was remarkably fine, and an immense concourse—an almost countless multitude—assembled to witness the operation, in the large square in front of the Hermitage, or winter palace of the Emperor.

The monument is of red granite, or rather sienite. The pedestal, which is square, is forty feet high; the shaft is round and in one piece, and is eighty-five feet high, and twelve feet in diameter at the top. It weighs six hundred tons and supports a colossal bronze statue, representing an angel holding a cross.

The statue, with its pedestal, including the capital of the column, is thirty-five feet high; and the hight of the monument, from the ground to the top of the statue, is one hundred and sixty-five feet. The stone was brought from Finland, and transported to St. Petersburg in a ship built for the purpose, towed by a steamboat.

The inclined plane on which the shaft was rolled from the river Neva to its

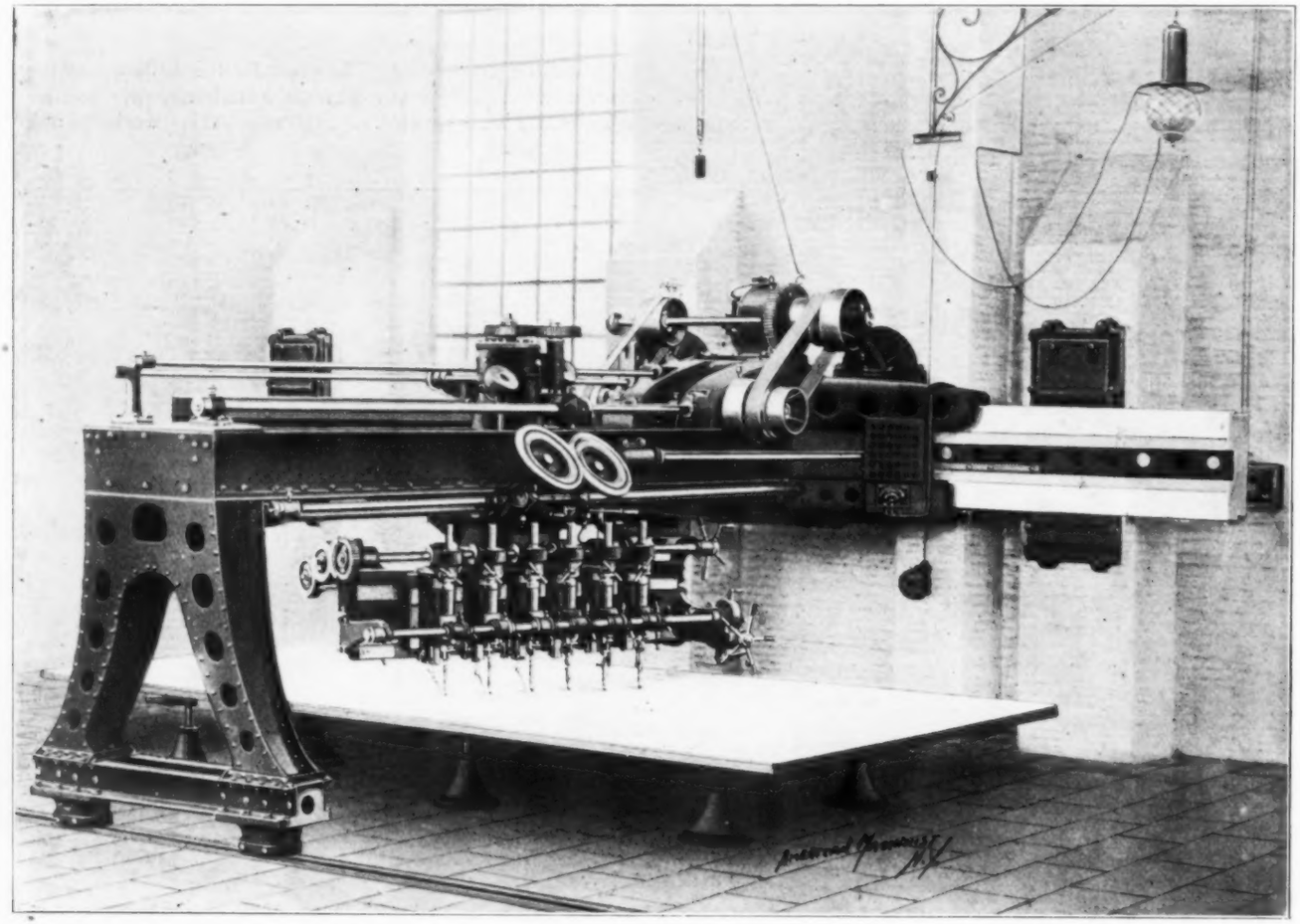


FIG. 4. GERMAN PLATE-DRILLING MACHINE

present site, contained a forest of wood, and cost in that country, where it is so cheap, a million of roubles, or 200,000 dollars. The column was raised and safely placed on its pedestal by means of sixty capstans, manned by 2500 veterans, who had served with Alexander in his most glorious campaigns. Each of them wore badges of honor.

The preparations for the stupendous undertaking were so complete that not the slightest accident occurred; and during the operation of raising the shaft, not a whisper or a word was heard throughout the vast multitude who witnessed it; the most profound silence prevailed and one of our friends, describing his own sensations, says he "felt as if it was criminal to draw a breath."

A Milling Machine with Universal Spindle*

A new model of a milling machine has been developed recently by P. Huré et Cie, Paris, France. It is provided with a single-pulley constant-speed drive and several other modern devices. The most prominent feature is a spindle head arranged with double joints, which render it universal; that is, the cutter spindle can assume any desired position, either vertical, horizontal or inclined.

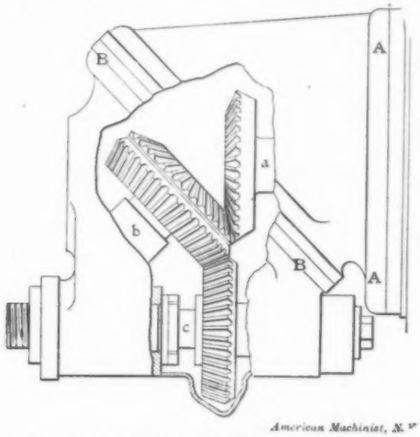


FIG. 1. UNIVERSAL SPINDLE HEAD WITH DOUBLE JOINTS

The Universal Spindle Head

This head is composed of two members, pivoted the one upon the other, both together carried on a bearing on the machine pillar. These two joints are circular in shape and are located the one in a vertical plane (see reference letter *A* of Fig. 1), the other in a plane inclined at an angle of 45 degrees with the first and indicated by *B* in Fig. 1. A train of bevel gears drives the cutter spindle *C* from the machine spindle *A* in whatever position the parts of the head may be placed. From this fact the cutter spindle can be revolved and inclined in all positions and perform all possible operations of milling. To move the head from one position to the next, it is necessary to turn either one joint, the other, or both, as the relative positions require.

The principal and most interesting positions are represented by the illustrations, Figs. 2 to 7, inclusive.

Normal Horizontal Position

This position is illustrated by Figs. 1 and 2. As in many horizontal milling machines, the cutter arbor is supported by a center, carried by a vertical arm from the knee. This arrangement permits of heavy cuts without springing the cutter. If it is desired to work on very large pieces and the distance, when the table is dropped to its lowest position, is insufficient, it is possible to increase the capacity of the machine in this direction by turning the head around the vertical joint *A* of Fig. 1; the axis of the cutter always remains horizontal. In this way the distance between the cutter and the table can be increased to 365 millimeters (about 14½ inches).

Vertical Position

The vertical position of this spindle head is shown in Fig. 4. The design of the column is such that when the head is in this position the distance between the vertical spindle and the table, and the character of cuts which can be taken, are the same as in an ordinary vertical milling machine of a corresponding size.

In general all of the parts remain in a vertical plane; however, the spindle can be inclined either to the left or to the right, as shown in Fig. 5.

It is also possible to swing the spindle into a horizontal position parallel with the length of the table (see Fig. 6). This position is of particular interest for it permits the utilization of the machine for boring, employing the automatic feed of the table in either direction as desired.

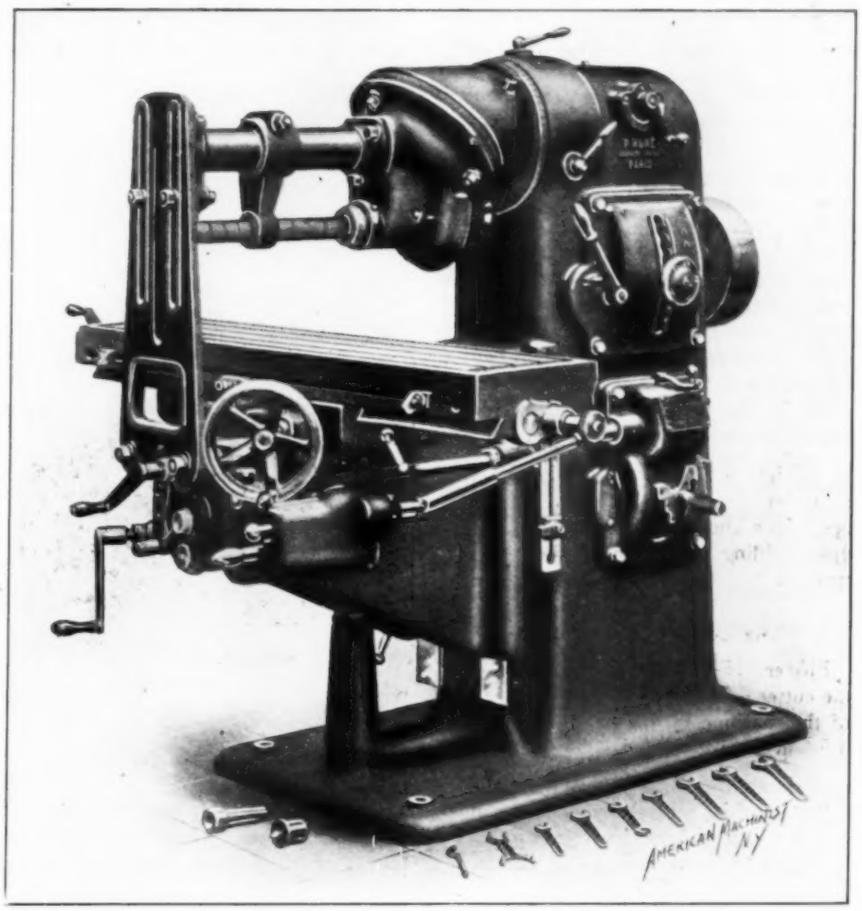


FIG. 2. ASSEMBLED MILLING MACHINE WITH UNIVERSAL HEAD

Horizontal Oblique Position

For cutting spirals, in contrast to the methods used with ordinary universal milling machines, the table remains fixed in direction, and the spindle is swung to the side an angular amount, depending upon the angle of the spiral. All of the parts remain in the same horizontal plane. This position is represented by Fig. 7 and possesses the advantage of permitting the cutting of spirals with very acute angles, such as would be beyond the limit of the setting of the ordinary machine table.

Indexing tables are provided for all angles, giving the graduations to which the joints must be set.

*Condensed translation from *La Machine Moderne*.

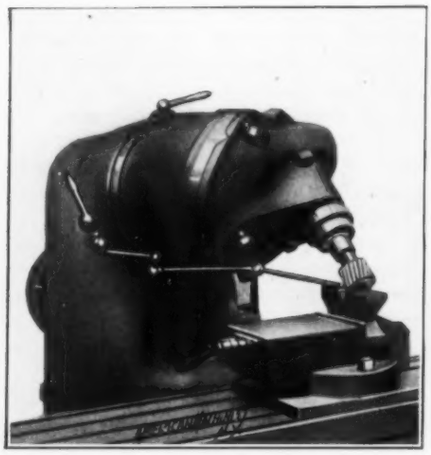


FIG. 3. CUTTER SPINDLE IN A FRONT INCLINED POSITION

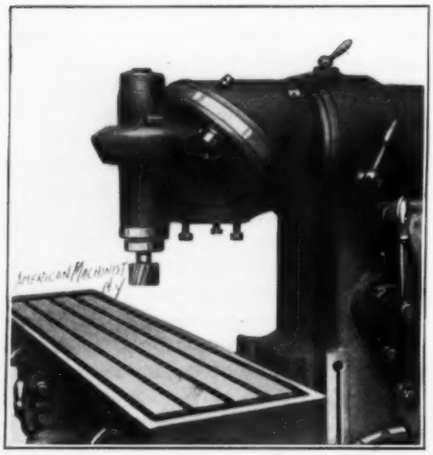


FIG. 4. CUTTER SPINDLE IN A VERTICAL POSITION

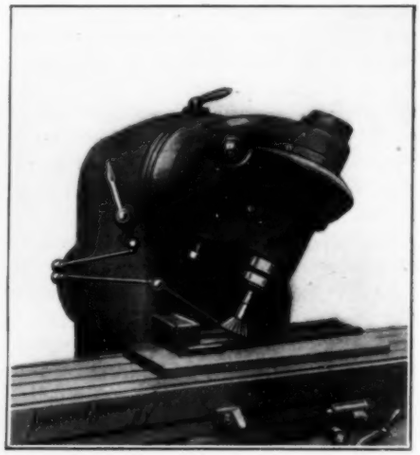


FIG. 5. CUTTER SPINDLE IN A SIDE-INCLINED POSITION

Inclined Position

When cutting a V, for example, the spindle is inclined in a plane perpendicular to the ways of the table. An end mill may be used, cutting both on the end and cylindrical face, and at one cut machine both surfaces of the V. Thus a special milling cutter is not required. A table indicates the angle which must be used for this setting.

Finally the cutter spindle can be placed in positions which are absolutely necessary in order to perform certain machining operations and which cannot be executed upon milling machines of the ordinary type.

The Constant Speed Drive

Fifteen different speeds are provided for the cutter spindle, controlled from the side of the machine by a knob which has five different positions, and a lever shown at the upper part of the pillar which has three positions. These levers are operated simultaneously and very rapidly.

Beside this feed-changing mechanism can be seen a long lever controlling a friction clutch, whereby all of the movements can be either stopped or started, as desired.

Feeds

The automatic feeds, longitudinal, transverse and vertical, are independent of the number of turns of the cutter. The control of the feed is by means of a box of gears of the Norton type, so arranged as to give a powerful and smooth drive. Twelve different feeds are provided and a change can be made from one to another by the moving of two levers, shown on the side of the machine in Fig. 2 and a little below the table.

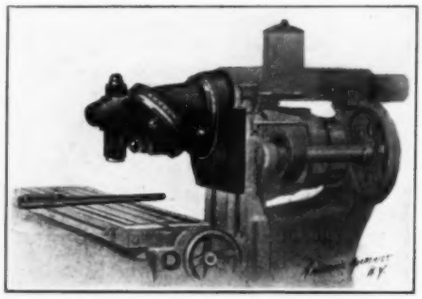


FIG. 8. UNIVERSAL SPINDLE ATTACHMENT APPLIED TO A PLAIN HORIZONTAL MILLING MACHINE

Electric Drive

The machine shown is arranged to be driven by a constant-speed pulley, but it can also be fitted up for electric driving. All that is necessary is to mount a motor upon a base plate at the rear of the pillar and connect it directly to the pulley shaft.

Application of the Universal Spindle Head to a Plain Milling Machine

The advantages of the universal head constitute the principal characteristics of this universal milling machine constructed by the firm of P. Huré et Cie. This head has, therefore, been adapted to plain milling machines of the ordinary type. Fig. 8 shows such an application. The front vertical dovetailed bearing of the pillar is extended to the front bearing for the overhanging arm. This forms a solid support for the universal head. By this application a plain milling machine can be used for cutting spirals and for the special classes of work which are performed upon universal machines.

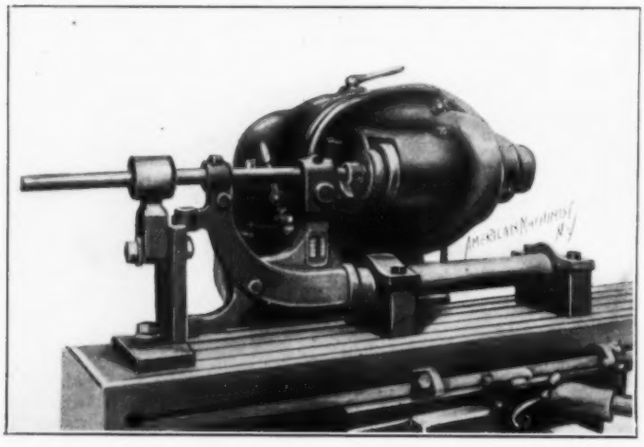


FIG. 6. CUTTER SPINDLE IN A HORIZONTAL POSITION PARALLEL WITH LENGTH OF TABLE

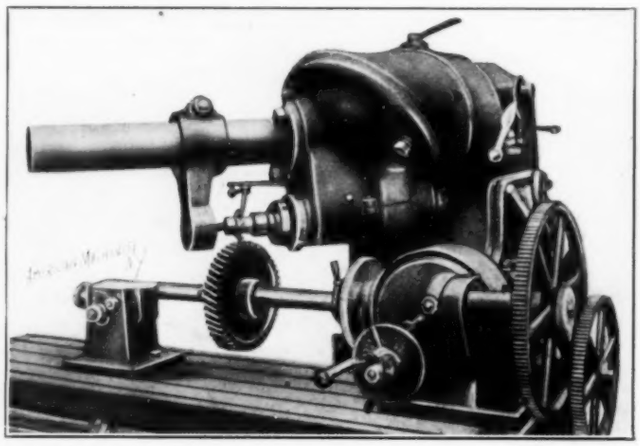


FIG. 7. CUTTER SPINDLE IN A HORIZONTAL POSITION OBLIQUE TO THE LENGTH OF THE TABLE

The Card Index System of Filing Notes and Clippings

By F. A. Halsey

The renewed interest in the subject of filing systems for clippings from technical papers leads me to republish the following article from our issue for October 27, 1898:

Many have wrestled with the problem of filing and indexing clippings from technical papers and notes of personal experience and with more or less, though usually less, satisfaction. A scrap book and a note book usually form the starting point, and they answer for a time. The pasting of a scrap book is a nuisance at best, but more serious is the fact that as the collection grows and individual clippings lose their places in the mind, the necessity for indexing arises, and the clippings being inserted in order of time, articles which belong together are naturally widely separated and eventually will be found in different volumes. The bulk soon gets formidable, and the chronic case of the article which is printed on both sides of the sheet is a constant nuisance. In the course of years much of the matter becomes commonplace, and would be removed if it could be, but this the paste forbids, and sooner or later the scrap-book scheme, which was adopted as the obvious method, is found to be entirely inadequate. The note book has nearly all the drawbacks of the scrap book, though smaller in degree, because the number of notes is naturally less than the number of clippings.

A CARD INDEX FOR NOTES AND CLIPPINGS

Expansibility Necessary

Many who have advanced beyond the scrap-book stage use the plan of a series of envelops, alphabetically marked and arranged. Others use the bellows file, while the portfolio scrap book has found some users; in fact, my own first attempt was with the portfolio scrap book, and the present plan was adopted when it was found inadequate. The chief difficulty with any system of separate pockets or receptacles is that some of them soon get full to overflowing, while others are still nearly empty, and the full pockets have to be divided. If the pockets are attached together, as in the bellows file and portfolio scrap book, this upsets the alphabet provided by the maker. The old letters must be removed and new ones attached, and this must be repeated whenever a pocket gets so full as to need dividing. The whole arrangement is thus in a constant state of transition and a permanent alphabet is never reached. When the file as a whole is full and a second one becomes necessary, the alphabet, as a whole, must be divided and again rewritten, one-half being given to each file, or, if this is not done, and each file has a complete alphabet, the two must be searched through whenever an article is wanted. Moreover, when a pocket has been divided it becomes necessary to search through two or more pockets for a needed article. All these plans have the further objection that they are not large enough. They answer after a fashion for small clippings, but a satisfactory file should take in magazine articles and pages from pamphlets, at least as large as the standard 6x9 page, without folding. A large clipping or series of them folded to go into a small file is awkward. The flat letter-file plan is better on this account, but has the objection of being limited in capacity.

A Satisfactory System

The accompanying illustration shows the vertical-filing system, now so largely used for office correspondence, applied to this purpose. The box shown was, in fact, originally intended and sold by the maker for a letter file, but it is an ideal appliance for a clipping file. It is simply

a large card index without the cards. Partition cards with the alphabet printed on them, as shown in the illustration, go with it, and in place of the angle blocks at the ends of the usual card-index box, a follower board is used having two sharpened wires and a thumb piece, by which the points of the wires may be thrust into the sides of the box. This enables the board to be pressed up against the contents of the box, and held there, so that the clippings soon get pressed flat and lose their tendency to open out.

Simplicity of the System

In use, the articles which it is desired to preserve are simply clipped out, and, to insure uniform size, are folded over a piece of stiff pasteboard kept in the box for that purpose. A letter is written at the title of the article to indicate its place in the index, the clipping is dropped into place, and that is all there is of it. The index letters on the clippings are necessary to insure their replacement where they belong after consultation. Many articles may be indexed under several heads, and unless the index letter is used an article is sure to be dropped into the wrong place some time in the future.

Filing Notes

In connection with this box I have a supply of stiff double-ruled paper, cut to the size to which the clippings are folded, on which the notes which formerly went into a note book are written, and then dropped into place among the clippings—the box being thus at once a scrap book and a note book. In the case of small clippings, which are apt to get down in the bottom of the box under foot of the others, so to speak, I paste them on these cards and so make them hold up their heads and maintain uniform size among the contents of the box.

Subdivision

If the matter under a given letter becomes so bulky as to make further division desirable, it is easy to add subdivision cards so that the A space is divided into two, the first running from Aa to Al, and the second from Am to Az, and this process may be carried as far as desired. Another plan of subdivision is to insert subdivision cards for special subjects. Thus, under B may be a subdivision for boilers, under C one for chimneys, under E one for engines, and so on, and obviously both methods of subdivision may be, and in a large collection should be, used together. As the collection grows and the box gets crowded, it is only necessary to provide a new box and transfer half the alphabet to it, as in the case shown, the plan thus being indefinitely expansible and yet always in ship-shape.

Summary of Advantages

Please note the advantages of this method. First, the articles on any given subject are together. Second, except for the small clippings already mentioned, there is no pasting. Third, when, as is often the case, an article may be equally well indexed under several heads, it may be placed under one and then be cross-indexed by cards containing the title of the article and references to the place where it may be found, and dropped in place under the other heads. Fourth, except for this and the writing of the index letter, there is no indexing involved. Fifth, the article printed on both sides of the sheet offers no difficulty. Sixth, the occasional case where an article is printed on the back side of another is easily met by dropping a card in the division for the second article with its title and the inscription, "See back of article on * * * indexed under division X." Seventh, notes and clippings are kept together. Eighth, articles may be removed and taken to the shop if desired and dead matter may be weeded out. Ninth, references to articles not clipped may be indexed on the cards, and references to books by chapter and page may be indexed in the same way; in fact, in addition to being a file of notes and clippings the box is also an index rerum, a sort of universal knowledge box so to speak. Tenth, indefinite subdivision is possible. Eleventh, there is no limit to the degree of expansion of a collection. Twelfth, bulk and waste room are reduced to a minimum; in fact, the capacity of such a box is astonishing. If any other plan offers so many advantages I am not aware of it.

As already stated, the size of the box should be such as to take in the standard 6x9-inch page. One folding of a page of the American Machinist and of many other papers brings it to this size. Unfortunately my own box dates from the time when there was no standard size of page and it is too small (5x8 inches). A convenient length of box is 12 or 14 inches.

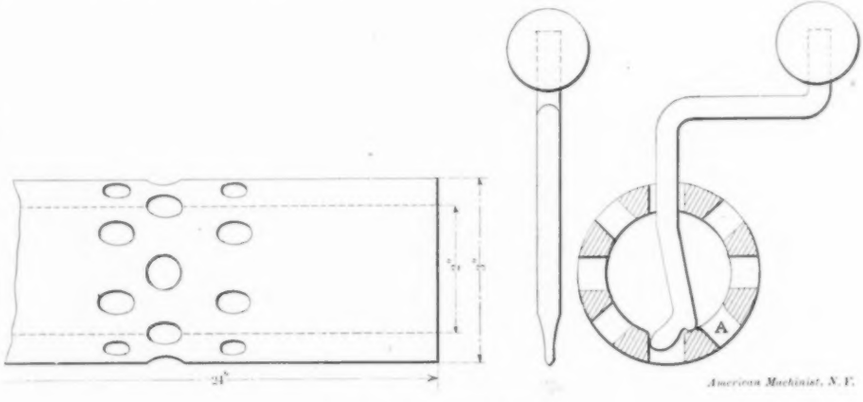
In starting such a collection the plan should be such as to involve a minimum of labor, or it will not be kept up. This condemns any system involving much pasting or indexing. No unnecessary trimming should be done. A clipping should never be notched down to the title below the top of the column, nor be notched up to the end of an article which does not finish a column. Such trimmed articles are more easily torn and do not fold as neatly as those having all columns left full. The margin of a newspaper page should be left on, as on its two sides it usually carries the name and date of the paper from which it came, and this may be useful to know at some future time.

A Handy Burring Tool

By R. Bettermann

The sketch shows a device for the removal of the bur caused in drilling the holes in a brass bushing for a hydraulic-crane controlling valve. In this valve there are three groups of holes arranged in three rows each, like the group shown in the sketch, these holes acting as inlet and exhaust ports.

The balanced piston valve with the cup-shaped leather packing would be seriously cut on the sharp edges of the holes in passing them on the inside unless the sharp bur were well removed; and if possible a round corner should be produced at the edge of each port hole. I accomplished this burring and corner-rounding operation with the tool shown. A piece of 3/8-inch round steel was bent in the shape of a crank at the one end with a knob for the palm of the hand to rest on and so produce a slight pressure on the cutting edge of the flattened end of the foot-shaped lower part. This shape permits the ready passing of the tool through the opposite hole which acts as a guide while the tool is revolving below. The tool is rounded off to cause an easy sliding action opposite the cutting edge under the heel of the tool. The result is indicated in the hole *A* where the inner edge is shown properly rounded. This tool has been used for more than six years, and accomplishes the desired results with little exertion upon the part of the operator.



A HANDY BURRING TOOL

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Hose-pipe Testing Machine

The accompanying half-tone, Fig. 1, and line cut, Fig. 2, show two views of a machine used in a shop where large quantities of hose pipe are annually bought and used for high-pressure air service to determine the real difference in value between different samples of hose submitted by manufacturers.

It was designed to take samples of hose 20 inches long; the air pressure applied to the hose while the machine is working is 90 pounds per square inch, while the vertical stroke is 14 inches, and there are 40 double strokes per minute. The long vertical connecting rod shown in the half-tone is coupled to a disk crank running on a shaft overhead. It will be seen at once that only a good sample of hose will stand up to the rapidly occurring kinking action. Fig. 2 shows how this occurs on the bottom end of the stroke, while naturally on the top end of the stroke the kink takes place at another part of the hose. It is said that most samples last from 1 to 25 hours of continuous running under this action, while cases have been known where 40 hours of running failed to develop weakness. It should be observed that besides this severe test the samples are subjected first to a hydrostatic pressure of 600 pounds per square inch.

Gloucester, Eng. PHILIP BELLOWS.

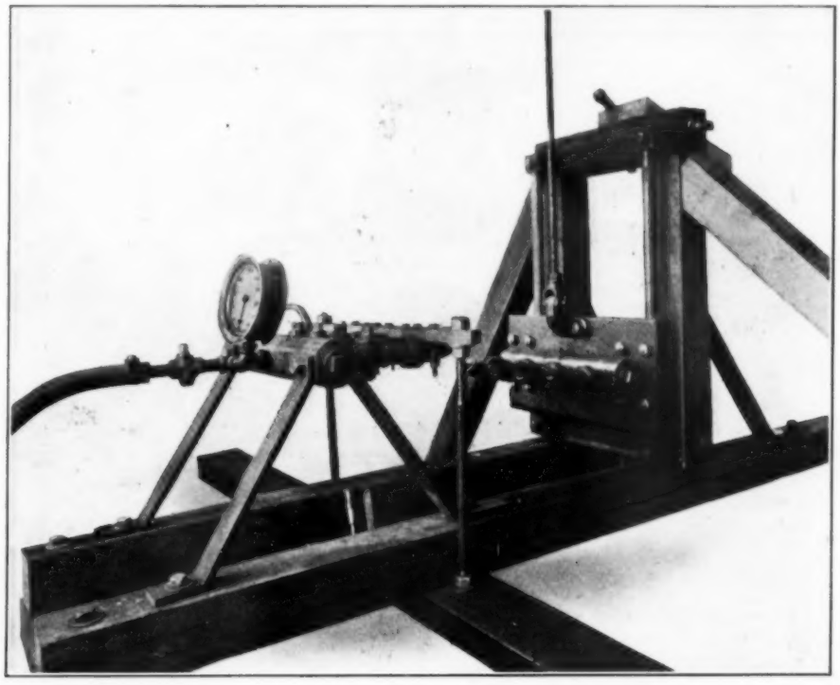
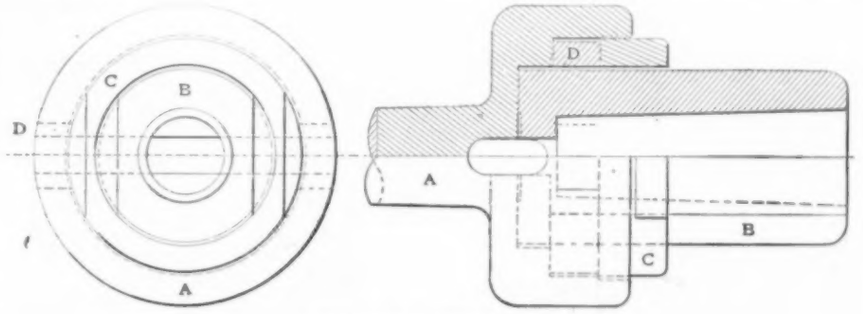


FIG. 1. A HOSE TESTING MACHINE

A Floating Reamer Holder

Every mechanic has doubtless experienced trouble when reaming holes with the vertical or horizontal drilling machine owing to the spindle not being set exactly concentric with the hole, the result being a taper or a barreling hole, and often, especially in the case of long holes through steel, a broken reamer.



A FLOATING REAMER HOLDER.

The line cut shows a floating holder designed to obviate these risks, and it has answered its purpose well. Although the idea is by no means new, its application in this particular way may be of interest to some.

A similar holder has also been in use for some time in conjunction with jig boring on the horizontal boring machine; that is, boring where the job is fixed in a jig where the boring bars are guided by bushes, the machine spindle merely driving. Any operator knows the difficulty experienced in getting the machine spindle exactly in line with the jig bushings, and the mortification of finding a hole bored too large with a cutter under size. With this holder between the spindle and boring bar the two may be 1/32 inch eccentric and yet the bar move freely and without spring in the jig bushings.

The mild-steel body *A* has a shank of convenient taper, in this case No. 5 Morse. It is bored 1/16 inch larger than the head of the socket *B*, threaded to receive the threaded ring *C*, and slotted to receive the arms of driving ring *D*. The socket *B* is bored No. 5 Morse and flatted nearly its whole length on opposite sides to fit easily into the tool-steel driving ring *D* which is prepared to receive it. The tools are

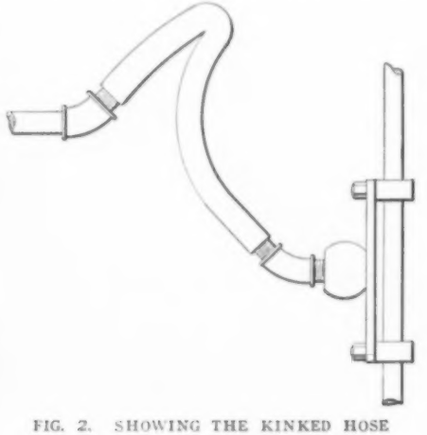


FIG. 2. SHOWING THE KINKED HOSE

ejected from the socket *B* by means of the usual drift through a slot made in *A* and *B* to coincide with each other. Two flats are provided on *C* to enable it to be screwed into place and readily adjusted when more or less "play" is required for the head of the socket *B*. The arms

of the driving ring *D* are made to move freely in the slots in *A* while its annular part has 1/16 inch clearance all around. The threaded ring *C* is generally adjusted sufficiently to keep the driver ring *D* and through it the head of the socket *B* well against the bottom of *A*, sufficient space only being left to enable it to float.

G. HANSFORD.

Loughborough, England.

A Handy Bell Chuck for the Grinder

The bell chuck which is shown in Figs. 1 and 2 has been found a very valuable attachment to our grinders. Nothing new nor original is claimed for it, however.

We were often held up on our grinding operations when the small machine was doing internal work and we had large lots of bushings to grind. We use large quantities of bushings of various sizes, ground inside and outside; our limits on these bushings, in hole and outside being 0.0002 inch. These were ground inside first, put on an arbor and ground outside. Very often, however, we could have kept our larger grinder busy on this work if we could have ground the outside first, but it was found that the three-jaw universal chuck was not accurate enough to allow this and several makeshift devices were tried with very poor success. We, therefore, concluded to make something which would do either operation first and the bell chuck was the result.

Shortly after the chuck with its adapters and bushings was finished, we came across a pamphlet of the Landis Tool Company with illustrations and descriptions of the Nos. 1 and 1½ internal grinding machines and on the last page found an illustration and description of their bell chuck. The dimensions vary somewhat and a few features were added in our chuck, as shown in Fig. 2, such as the push-out rod with disk and spring, which runs through the spindle of the machine, and four holes in the body of the chuck to allow dust to be blown out. Bushings, straight as well as taper on the outside are centered absolutely true, the inside of the chuck as well as the adapters and bushings having been ground in position on the machine. The work finished in this chuck comes out as near perfect as possible and the time and material we have saved in two months' use have paid for the cost of the complete chuck. The manner in which the adapters and bushings are split gives them a very wide range of compression and saves considerable time on the roughing-out work on the lathe when the hole is ground first.

The holes in the bushing blanks are bored and reamed 0.002 under size. When the large grinder is busy we grind the hole first, but often reverse the order of these operations, the variations in the rough outside diameters being taken care of by the expanding adapters and bushings. The taper adapters extend about ⅜ inch beyond the face of the chuck in their normal state and the large nurled nut forces the adapter in the taper bore of the chuck closing it uniformly and positively. It was found, however, that on ordinary work it was not necessary to use this nut, as the grip is quite sufficient for grinding if the work is pushed in place by hand. Altogether we have found the arrangement of great advantage and since having learned that the chuck is on the market, I have wondered why it is not in more general use.

In connection with this work I had a rather unusual experience. The bushings we use are mostly of cast iron and are ordered 300 or more at a time. I found that after they were bored and reamed we always had to scrap so many, in fact sometimes 25 per cent. or even more, that I began to look for means to prevent this loss of labor and material. The trouble was due to defects in the iron, the hole when finished being required to be absolutely smooth and sound, without any sand or blowholes.

A visit to the foundry and careful examination of conditions showed that the best iron for the purpose was used, also that every possible care was taken to insure a good, sound casting; yet the results were very unsatisfactory. I suggested to the foundryman that he let me make some iron cores and try what that would do. I actually believe he thought I was crazy and he almost said so, adding that he would make some that way if I wanted them, but that they would be so

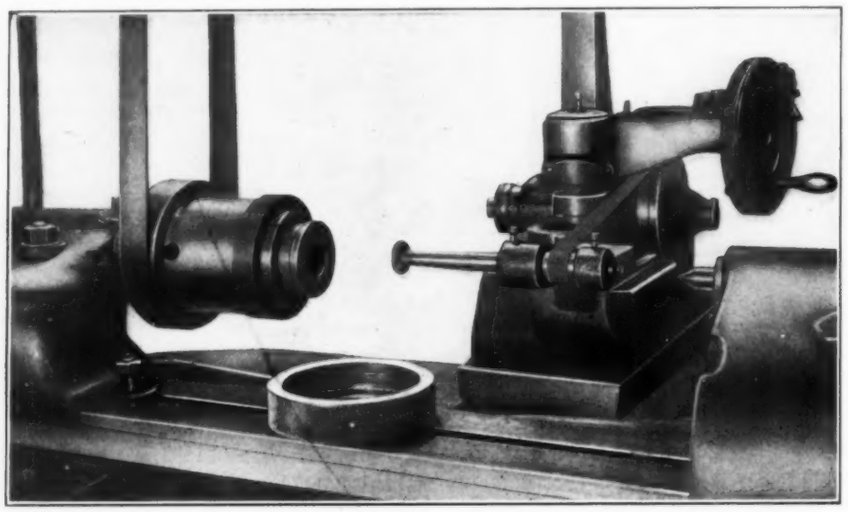


FIG. 1. BELL CHUCK ON THE GRINDING MACHINE

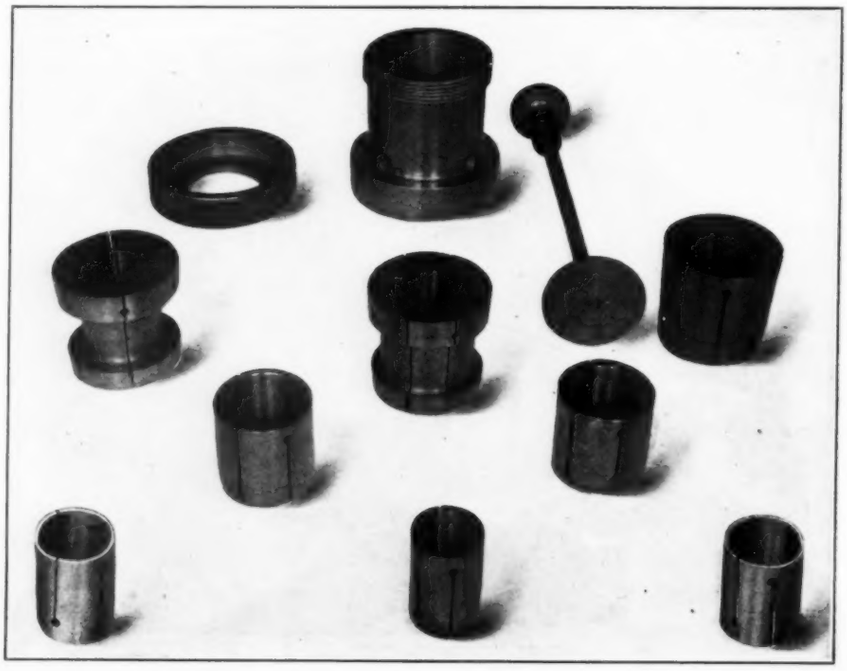


FIG. 2. BELL-CHUCK PARTS

hard that I would be unable to machine them. I told him that I would take care of that part of the work and I made the iron cores and a lot of 50 bushings were cast, with many sarcastic remarks by the foundrymen.

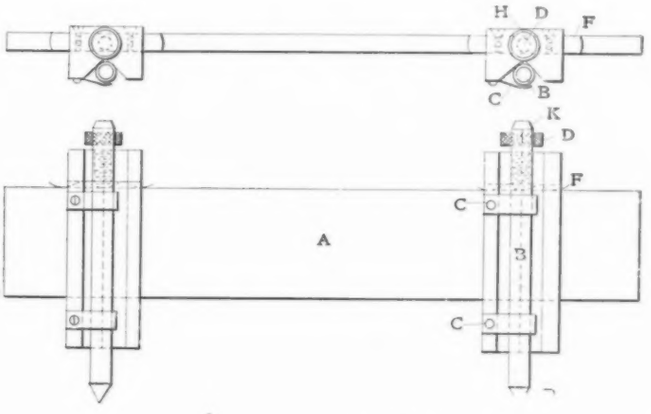
When the castings were delivered to the machine shop, I had them taken to the Jones & Lamson machine, and, starting the machine at a slow speed until the tool was well under the scale, it was then speeded up to its usual speed and the castings bored rough and finished. They were next reamed to size. Of course, all tools used on these operations were of high-speed steel.

The results were surprising. Out of the 50 castings not a single one was scrapped, all coming out perfect in the bore and there was no appreciable increase in the time spent on the operations. These bushings were 3 inches outside diameter, 2 inches bore and 3½ inches long, finished dimensions. We have since adopted this method of casting bushings for all our sizes, which are cored and have obtained the same uniform and satisfactory results.

Albany, N. Y. L. F. C. GEORGE.

A Laying-out Tool

A short time ago, while visiting another shop, I had the opportunity of looking through the kit of J. B. Douglas, a toolmaker formerly with the Waltham Watch Company, and among other interesting devices, was the laying-out tool I am about to describe. Unfortunately, I did not have my camera with me, so I will have to depend on my memory for the accuracy of the drawing shown here.



A LAYING-OUT TOOL

The tool was originally designed for accurately laying off the dimensions for the spacing of drill bushings in jigs of various kinds and sizes. Referring to the drawing, the beam *A* is a heavy Brown & Sharpe scale graduated in fortieths. The two sliding heads are exactly alike and the bodies are made of tool steel, hardened, ground and lapped true. These heads are slotted out on the back a little wider than the width of the scale and are held on by steel plates *H*, doweled and screwed on with flat countersunk head screws.

In the slot and on the top edge of the scale is a piece of stiff spring bent, as shown at *F*. This spring not only serves as a friction stop for the head, but also serves as a guard for the end of the set screw *D*, preventing it from injuring the scale.

In the front side of the head is a carefully ground V-groove. In this groove is a punch *B*, held in place by two springs *C C*, making it possible to move the punches up or down in a line parallel with the sides of the V. These punches are hardened their whole length and carefully ground exactly 3/10 of an inch in diameter, the points *P* being ground exactly concentric with the body of the punch. The top of the punch is slightly beveled as at *K*.

To use this tool, one head is locked on the scale by means of the set screw *D*, and the other head set approximately the required distance by sliding along, measuring by the divisions on the scale and reading from the same side of both heads. The tool is then laid flat on a plate and the exact distance obtained by adding 3/10 of an inch (the size of one punch) to the required distance and measuring from the outside of the ends of the punches with a micrometer. The punches are then pushed up until the points are flush with the bottom *M*.

If one hole has already been located by a center-punch mark, one punch is set in this mark and the other punch tapped just hard enough to make a visible mark. Where several holes are to be located at different angles from a common center or starting point, a protractor and ground steel parallels are used. A steel parallel may also be placed at the back of the tool to steady it when in use. After being marked the centers are indicated and the holes bored out in the usual way.

Decatur, Ill. ETHAN VIALL.

Thread Rolling Dies

The average machinist is not familiar with thread-rolling die practice, therefore a few points on laying out this class of die may prove useful. Dies for this purpose are made in various shapes and sizes, but all threads are rolled between a pair of grooved surfaces, one stationary and the other either reciprocating or revolving past its partner. I shall consider here only the former method, the face of one of these dies appearing as in Fig. 1. It will be seen that the grooves form an acute angle with the sides, and this angle is to many the mystery of thread rolling. One method of laying out dies is as follows: After coppering the face of the die, Fig. 2, take a piece of rod the size of the blank, which must be the size of the screw desired less $\frac{0.866}{\textit{pitch of thread}}$ or depth of thread, square one end and place a mark on the blank and the die as at *a*. Now, keeping the rod square with the die, roll carefully along, say, four turns, and mark the die again at *b* coincident with mark *a* on the rod. Now lay a line from *a* or *b*, depending upon whether the thread is to be right- or left-hand, square with line *a b*, and measure off a point *c* equal to four times the lead of screw; connect *c* and *a*, and cut grooves parallel with this line. In the hands of a careful workman, this method, although crude, gives very good results.

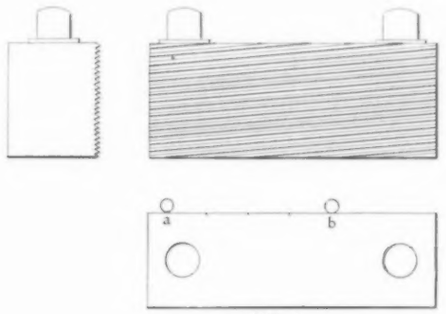


FIG. 1

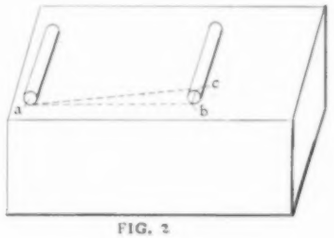


FIG. 2

LAYING OUT THREAD-ROLLING DIES

If, however, we wish to work with the aid of figures, proceed as follows: Suppose we desire to roll 8x32 or 0.16312x32; we subtract the depth of the thread, in this case 0.0433 inch, and obtain 0.1198 inch for the size of the blank. Find the circumference, which is 0.3763 inch. Now divide the lead of thread in one turn, or 0.0312 by this sum, giving 0.0831, which is the tangent of the angle desired. From a table of tangents we find this to be 4 degrees 45 minutes. This method is the same in all cases of single threads.

DANIEL F. MORIARTY.

South Meriden, Conn.

Simple Jigs for Connecting Rod Brasses

These jigs, while not elaborate nor revolutionary in character have been found to be thoroughly practical and allow for rapid and accurate production. It is to be noted that the brasses are tongue-and-groove lap, as it has been found that the lap joint with the aid of a locating pin in the connecting-rod brasses and the connecting rod proper permits the use of clearance holes for connecting-rod bolts. This, in a two-cycle engine with closed crank case, is an advantage. This lap joint, however, has always given us a considerable amount of trouble in getting the brasses absolutely interchangeable until we designed the present jigs.

The fixture illustrated in Fig. 1 is for the first operation on the connecting-rod cap, locating pins *A* being used to locate the rough castings, shown in dotted lines. This fixture has a locating tongue on the bottom which is not shown to fit in a T-slot on the milling-machine table. A gang cutter is used to face off the surface *B*.

The next operation on this piece is drilling the bolt holes by using drilling jig, as shown in Fig. 2, which is self-explanatory.

The fixture illustrated in Fig. 3 is the same as Fig. 1, only in that we use the bolt holes to locate the brass. This, of course, means that the operation of drilling these bolt holes should be finished first, which is done by drilling in the jig, shown in Fig. 4. In this jig we locate the brass by the locating pins *B*, the hole for the dowel pin being drilled at the same time. We might add that the surface only on the brasses is machined on a disk grinder before being placed on the drilling jig. To remove a casting from this jig all that is necessary is to slack off the thumb nuts *D* and remove the pin *E*.

Fig. 5 is used for drilling bolt holes and dowel-pin hole in connecting rod, using locating pins in the same manner as in Fig. 4. The screws *F* are used as clamp screws and have a clearance hole drilled in them to clear the drill before hardening.

Fig. 6 is used for boring and facing the ends. This boring is done on a 21-inch Gisholt turret lathe, the angle plate being placed against the chuck face, the angle plate having a shoulder *G*, the same diameter as the hole in the chuck which centers it. The two pins *H* are used to locate the brasses, the chuck jaw *I* being used for clamping. We have, however, found it necessary to make a piece to span the top of the brasses as even with the locating pins extending up half way in the top half of the brass, the chuck jaw had a tendency to spring the brasses. After overcoming this the brass was bored with the standard boring bar using combined fillet and facing tool in another bar and setting the stop on the turret to give us the right dimension. After boring and facing one side the brass was turned around on the same fixture and the other side faced.

Fig. 7 is used for drilling the oil hole *J*. The stud *K* being hardened, acts as a guide for the drill. You will note that this oil hole is drilled off center. The reason for this is that the connecting rods are used in marine engines which are generally placed on an angle in the boat so as to get the propeller well under water. This necessitates the oil hole being drilled in the forward end of the rod.

The wrist-pin hole *L* is bored on the milling machine between centers. We have found by using a standard 1½-inch mill, the one cut through makes a very nice finish and cuts to size. The use of this mill does away with one operation, as it is customary to bore these and ream them.

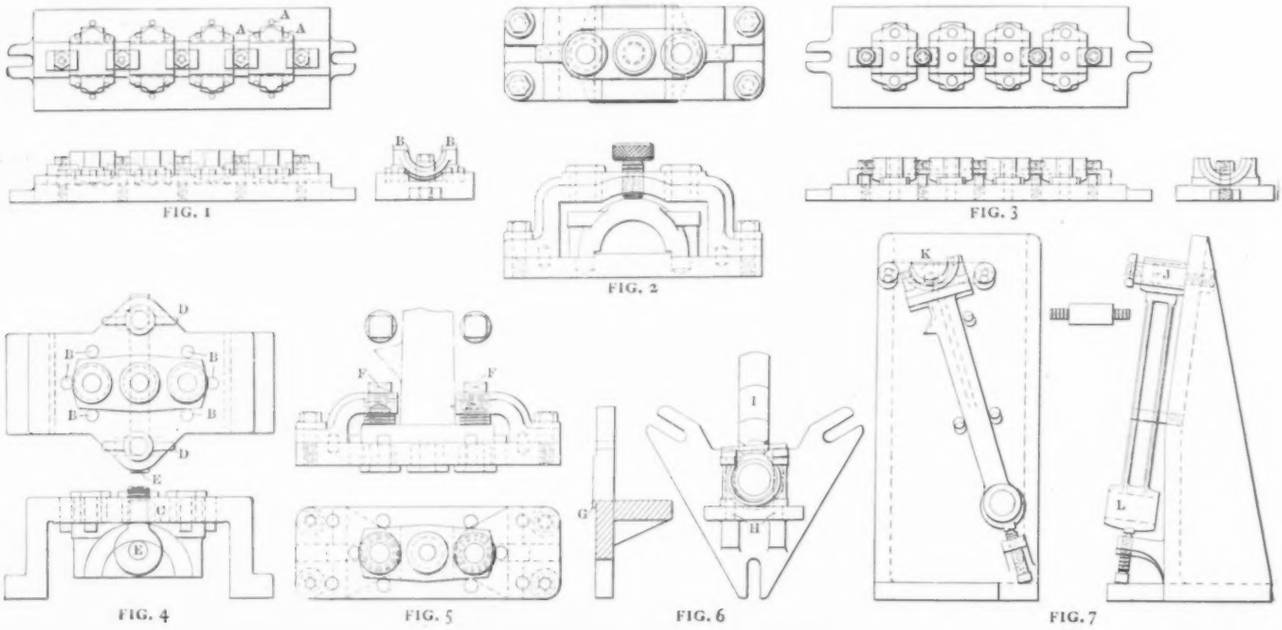
Baltimore, Md. F. W. NUGER.

Quick Japanning Method Wanted

Will some reader of the AMERICAN MACHINIST tell me how to japan or lacquer sheet-steel disks of 1 to 1¼ inches diameter?

These have to be lacquered in large quantities and a system is wanted such as for lacquering brass buttons or screws. Would prefer not to bake them if a quick-drying lacquer could be had that is easy to apply, such as dipping would do.

Preston, Eng. W. B.



JIGS FOR MACHINING CONNECTING-ROD BRASSES

A Thread Milling Fixture

The fixture shown in the illustrations herewith was designed to facilitate and cheapen the production of a variety of small arbors like that shown in Fig. 1. The arbors are made from tool steel and are cut off, centered and formed at the end to be threaded in the turret lathe. The diameters are sometimes 5/8 and at others 3/4 inch; the threaded portion may be 3/8 inch 16 threads, or 9/16 inch 20 threads, either right- or left-hand. As these pieces are hardened for a portion of their length (not including the thread), and the thread must run true with the bearings upon which they run, the threading operation is left until the last, or until after they are ground.

The fixture is arranged to fit on a plain milling-machine platen and, as shown in Fig. 2, consists of the base plate *A* (provided with tenon blocks *a*) upon which is mounted the swiveling angle plate *B*; a hub shown in dotted lines at *b*, is accurately fitted to a recess bored in the base plate *A* and serves as the pivot upon which the angle plate swivels. The binding bolt *C* is provided with a parallel portion, as shown, which has a double purpose; one being to furnish means of centering the cutter arbor, the other that of supporting the stop shown at Fig. 3. The angle plate *B* is bored to receive internally threaded sleeves *D*, and is split and provided with a clamping bolt *E* and a dowel-pointed screw *F*, as shown.

For each separate lead to be cut a threaded quill *G* is provided, together with a sleeve as at *D*. The quills are simple iron castings which we anneal before machining; the thread is cut after the hole through them is finished, and fitted with the spring collet *H*. The threads are lapped smooth and the quills marked with the part number of the piece they are intended for, together with the angle at which the angle plate must be set by means of the graduations shown on the base. The stop block, Fig. 3, is capable of adjustment both longitudinally and vertically as may be clearly seen. The stop is arranged to engage with the shoulder *X*, Fig. 1, by which means the cutter need never over- or under-run its course. The cutter is one of our own make, 1 7/8 inches diameter by 3/16 inch thick, backed off like a gear cutter and ground all over; the clearance angle has been carefully considered and the necessary correction made so as to secure a correct thread angle of 60 degrees. A great improvement in the quality of the work has been obtained by using this fixture instead of the lathe, the time required for the operation has been reduced 75 per cent., and a cheaper class of help can do the work.

Rochester, N. Y. L. W. G. FLYNT.

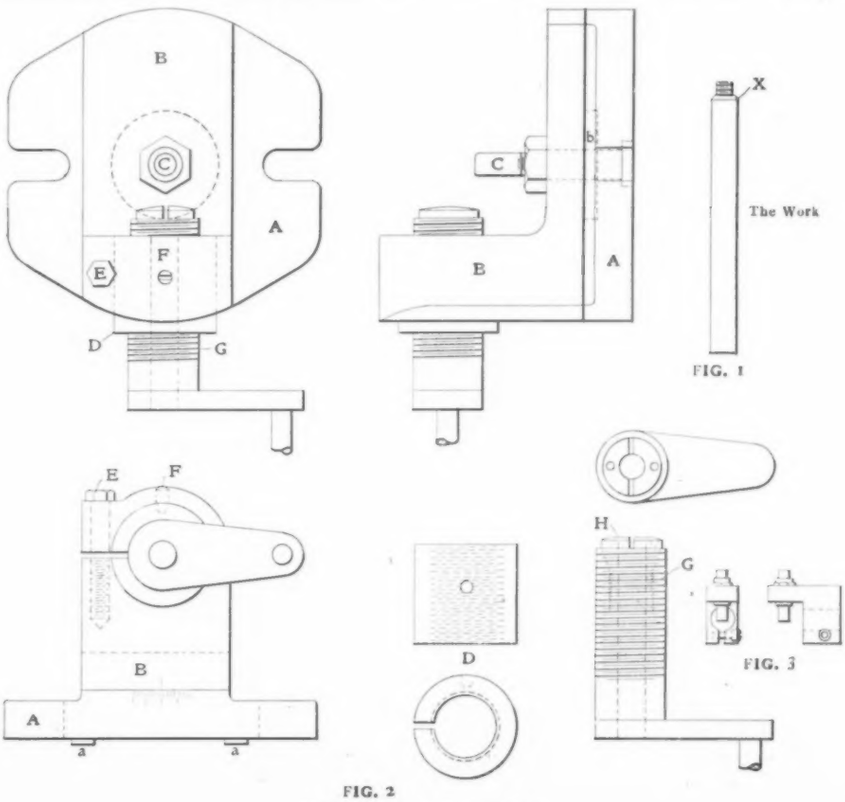


FIG. 1

FIG. 3

FIG. 2
THREAD-MILLING FIXTURE

Short (?) Cuts in Arithmetic

Some time ago I was beguiled into buying one of the so-called "handbooks" which are flooding the book stores at the present time. I have spent some time looking it over and have been especially interested in the work given under the above title. Now, I don't want anyone to take this article as an adverse criticism of handbooks in general but just a little objection to this one in particular. Such books as those of the AMERICAN MACHINIST, Kent, Foster, Trautwine, Carnegie, Cambria, etc., are superb and should be in every man's hands, if he is hoping for a better job some day.

This is one of the *short* cuts:

To find the diagonal of a square, knowing the length of a side:

Rule: Multiply the side by ten. Take away one per cent. of this product and divide the remainder by seven.

Example: Side equals 5.

$$5 \times 10 = 50$$
$$1/100 \text{ of } 50 = \tfrac{1}{2}$$
$$50 - \tfrac{1}{2} = 49\tfrac{1}{2}$$
$$49\tfrac{1}{2} \div 7 = 7.07$$

It made me think of that problem the boys like to spring on you. "Think of a number. Do a whole lot of things, subtract the number you first thought of and your answer is ten."

It is well known, of course, that the side of a square multiplied by the square root of 2 (1.414) will give the length of the diagonal. Now, that is all this *short* cut amounts to, as we shall see if we let the side be x.

$10 \times x = 10x$; 1 per cent. of $10x = 1/10x$ and subtracting this from our $10x$ we have $9.9x$ which divided by 7 gives us $1.41x$ or the square root of two times the side.

Another short cut is simply an adaptation of the trigonometric formula:

Area of a triangle = the square root of the expression $S\,(S-a)\,(S-b)\,(S-c)$, where a, b and c are the sides of a triangle and $S = \tfrac{1}{2}\,(a+b+c)$.

The rule, as given, is:

(1) Find one-half the sum of the three sides.

(2) Subtract each side separately from their half sum.

(3) Multiply these three remainders together and multiply their product by the half sum itself.

(4) The square root of the product obtained is the area of the triangle.

Example: Given a triangle whose sides are respectively 3, 5 and 6.

Find the area.

(1) $3+5+6=14$; $\tfrac{1}{2}$ of $14=7=$ the "half sum."

(2) $7-3=4$, $7-5=2$, $7-6=1$.

(3) $4\times2\times1=8$, $8\times7=56$.

(4) The square root of $56=7.483=$ the area. This rule is good for a triangle of any shape and often comes in handy around the shop.

There are many of the so-called short cuts like the first example mixed in with a few really valuable methods. It is interesting to note that the person who perpetrated this book is the president of a college in Boston and is the author of many books, eight of them being listed on the title page of this one.

Salem, Mass. T. P.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Increasing Production by the Premium System

I was much interested in the article at page 174, by T. A. Sperry relative to the premium system, and having had a little experience under the system when it was badly managed or applied, the telling of it may point out some of the dangers of any but the most careful application. The shop I was fortunate enough (?) to have had the experience of working in during the inauguration of the premium system has, I believe, been held up as a model more than once by the press.

The following is as nearly exact an account of what happened to me during the several months which I worked in that shop as I can at present remember:

I was running a good-sized boring mill and quite frequently ran out of castings; on these occasions I would go from one foreman to another asking for something to do until such time as more castings materialized for my machine. On one of these occasions I was given several hundred forgings to center and rough turn in a lathe. At the same time I was given a large printed form with certain blank spaces filled in by hand; this turned out to be a premium card, and I soon discovered that another man had one similar relating to the same job. His work was to finish turn the pieces.

At first I mis-read the card, and understood that I had nine hours to center the pieces, therefore I started with great speed to beat the time, and succeeded so well that I completed that step in about 4½ hours. I then discovered that the nine hours were not for the centering alone but for centering and turning both. My first thought was that there must be some mistake, but when I was assured that this was not the case and the utter absurdity of the thing dawned upon me, I regret to say that I swore to the best, or worst, of my ability. However, I soon got sane again and decided to finish up the job as quickly as I could and discover just how far the card was out.

The lathe I had access to was an old affair and in order to take the required amount off with one cut I had to keep pounding the belt with one hand, and before the nine hours were up I was drenched with sweat from this hand labor. Then to cap my troubles, which I can smile at now, but which appeared very real to me that day, someone came and told me that the superintendent and head foreman had been laughing at "that fool trying to beat the time card." Nothing further was needed to calm my nerves and I settled down to make the remainder of that job cost the shop as much as I could, and I probably succeeded, although I have never since experienced any great satisfaction over such puerile revenge.

The man who had the second part of that job to do was a German and his card was as absurd as mine had been, but he took things stolidly and finished about 50 hours behind time.

After that I went back to the boring mill and the cards began to come thick and fast and by comparing them I soon saw that the method of computing the time was, to say the least, at fault, if indeed any method was used. Such (to use expressive slang) "bughouse oddities" as the following were easily discovered by keeping a record of the jobs and time allowed. "One 6-foot pulley 12-inch face, bore, turn, and face both sides of hub—time 5 hours.

"One 6-foot sprocket wheel, bore and face both sides of hub—time 5 hours."

It will be at once apparent to the initiated that I never made my fortune doing the first job, while with any luck I could get the second through in 2 to 2½ hours, although I never discovered the advantage of beating the card so far as my pay envelop was concerned. It was always the same except when I happened to come in 30½ seconds past seven and get docked one-fourth hour.

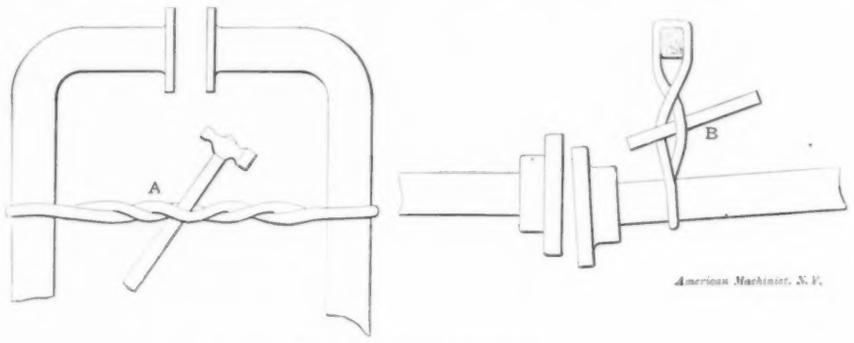
I found out that the expert who made out the cards was a young correspondence school M. E. (no reflection is intended upon the institution) and it would be interesting to discover how some of his "time" deductions were arrived at; however, his mistakes were more strikingly apparent when he made out the tags for different castings, consigning a 30-inch pulley to the mercies of a 26- or 28-inch lathe.

Ottawa, Can. N. E. ROLLEN.

The Spanish Windlass

The origin of the term "Spanish Windlass" is somewhat obscure, and as far as I have been able to ascertain it is not Spanish, and it is not a windlass, but of its utility as an improvised tackle there is not the slightest doubt. Among sea-going engineers it is a great favorite, as most of the machinery, etc., under their control is put together with a view to economizing space and is consequently not amenable to shop methods.

The accompanying line cuts show how it is applied at *A* for bringing two pipes together for jointing and at *B* for raising one end of a length of shafting to bring it into line for coupling up. It will be seen that it does the duty of a turnbuckle, screw, pulley blocks, or crowbar. The travel, or rather the length of pull exerted in proportion to the power applied to the "tommy" is enormous, being limited only by the strength of the rope itself. I have used it hundreds of times, and for as many different purposes, and I always regard it as one of the simplest and most useful emergency tackles. Many a time when working in cramped or otherwise inconvenient places such as the bilges of a ship, where it was not possible to use pinch-bar or pulleys, I have easily got over a difficulty by using a Spanish windlass on it, and frequently when I have been sent out into the country to overhaul engines, etc., I have been able to save considerable time by its use, particularly in some out-of-the-way places where the only available tools were a coal hammer and monkey wrench with a loose jaw.

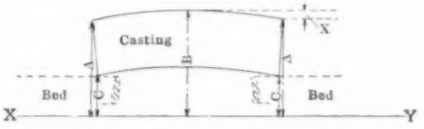


THE SPANISH WINDLASS

London, England. S. J. B.

Accurate Planing to Avoid Unnecessary Scraping

I was interested in the remarks of L. F. C. George, at page 683, and would like to suggest that he favor us with one or two line sketches, showing his method of holding down the erratic lathe beds mentioned, also a cross-section of the bed. We are told that it does not matter whether a machine be 2 or 20 years old, so long as it is best for the particular work it has to perform. This argument is very well, provided always that the machine be kept in such condition as to perform its work within reasonable limits of precision. I am inclined to think, from his remarks, that Mr. George is crediting the lathe beds with much that belongs to the machine. It is quite true that unaccountable differences appear in different castings, though set up and planed in precisely the same manner, and it is generally found, with this class of work that if, after "roughing" out, they are "seasoned" before finishing, more consistent results will be obtained.



MEASUREMENTS DESIRED TO SHOW SPRING

Mr. George tells us that the lathe beds invariably show 1/32 inch *hollow, unless pulled down at the ends.* To my mind, this points the error in the machine, not the casting—the invariable result proving precisely the same thing to be happening at each cut, whether the cut be one of 0.125 inch or 0.003 inch.

The comparison referred to would be between the center and either end, taken from the highest point in center to lowest point on ends along casting top. Referring to sketch, *A A* are the end dimensions, and *B* the center, all three being taken from points named to points in a horizontal plane, parallel to that in which the lower extreme ends of bed lie. These must be taken quite independent of machine bed. This will give some clue to the source of trouble.

Another somewhat remarkable feature of this "springing" is that, whether it be work or machine, its course is upward at the center, causing more metal to be cut away at that point. Surely a more reasonable assumption would be that the ends are sprung down in bolting, and then when released spring back to their former position, thus throwing the center hollow, in which case it would be necessary to pack the ends up—not pull them down—to allow for this, or better still, to support the center in such manner as to avoid any chance of springing.

I fail to see that the mere fact of the castings being "fresh" would answer for so consistently great an error as stated. A large number of minute errors are the undoubted result of the necessary working clearance between numerous working parts of the machine, but these are inevitable to a greater or lesser extent on all machines. These errors are controllable, however, and may be kept within such close limits as to be practically unappreciable at the tool-cutting edge. But, on the other hand, if undue wear is tolerated, then accuracy is out of the question. While fully admitting the seemingly unaccountable and frequently remarkable contortions met with in planer work, there is little doubt, providing the machine itself is right, these are—to an extent depending on the operator—aggravated or eliminated by the manner of setting and fixing. If it were possible to accurately determine every deviation in the finished surface, there is little doubt so slight error would be found at every point where the resistance offered to the cutting tool varied.

Coventry, Eng. H. PEARMAN.

Solution for a Problem in Levers

In working out the "Problem in Levers" at page 228, I find that my result does not exactly agree with that of your contributor, and herewith present my method of determining the quantities desired.

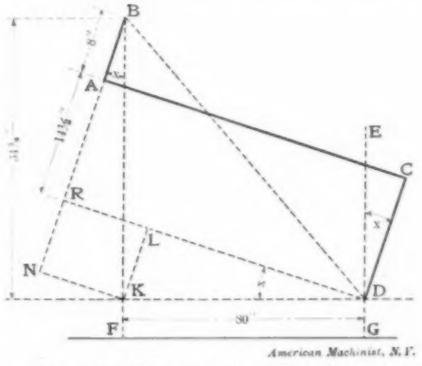


DIAGRAM ILLUSTRATING A PROBLEM IN LEVERS

Referring to the accompanying figure (which is intentionally distorted somewhat from scale to show the small angles more clearly), the link *B A* is continued, *D R* and *K N* are drawn perpendicular to *B A* and *K L* is drawn parallel to *B A*. The necessary dimensions are shown in inches.

To get the required angle *C D E*, which I have represented by *x*, we note that angles *C D E*, *A B K* and *R D K* are each equal to *x*.

$$R N = K L = K D \quad sin.\, x = 80 \quad sin.\, x.$$

$$B N = B K \quad cos.\, x = 34.75 \quad cos.\, x,$$

and

$$B R + R N = B N,$$

from which, substituting,

$$22.5 + 80 \quad sin.\, x = 34.75 \quad cos.\, x.$$

Solving we have $x = 8$ degrees 31 minutes 46 seconds, one of the results asked for.

The length of the link *A C* is found as follows:

$$A C = D R, \quad \overline{D R}^2 = \overline{B D}^2 - \overline{B R}^2,$$

$$\overline{B D}^2 = \overline{B K}^2 + \overline{K D}^2,$$

$$\therefore \quad \overline{A C}^2 = \overline{B K}^2 + \overline{K D}^2 - \overline{B R}^2 =$$

$$(34.75)^2 + (80)^2 - (22.5)^2,$$

and

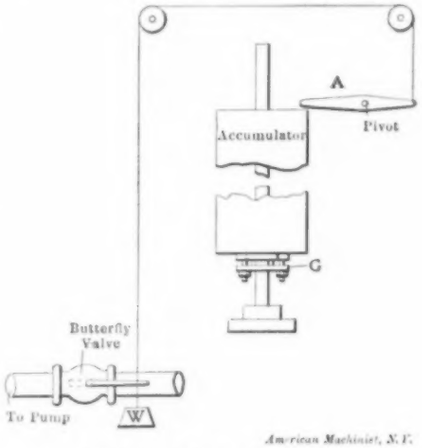
$$A C = 84.27'' = 7' \ 1/4''.$$

With the new arrangement desired, if the arm *D C* is to retain its former length, the point *D* will have to remain at the same distance, 10½ inches from the line *G F*. Assuming then that the new position of *D* is 8 inches horizontally to the left, and calculating *x* and *A C* by the same method, with the distance *K D* changed to 72, I find them to be, angle *C D E* = 9 degrees 25 minutes 4 seconds, and length of link *A C* = 6 feet 4 3/4 inches.

Notre Dame, Ind. W. L. BENITZ.

A Controller for a Hydraulic Accumulator

I note on page 145 an article on the above subject. I have had some experience with a large hydraulic system at the works of the Bettendorf Axle Company in Davenport, Iowa, and there we made use of a device which throttled the steam pipe to the pump. This plan, of course, has some disadvantages, but is very simple and easy to install. A cable is used in the manner shown in the line cut. You will



A CONTROLLER FOR A HYDRAULIC ACCUMULATOR

note that the accumulator acts on the cable by means of lever *A*, giving a positive closing action at the butterfly valve when the accumulator has fallen a sufficient amount.

In addition to this device a hole was drilled in such a position in the water column of the accumulator that when the packing gland *G* passes it the water will be allowed to rush out. This hole, of course, was high enough so that it acted as a last resort and it is quite evident that such a stream would not fail to attract the attention of the engineer.

Chicago, Ill. W. E. MOREY.

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A Court of Patent Appeals

For some years past the country at large and inventors in particular have been facing the serious difficulty of nine possible courts of patent appeal, with a possibly similar number of diverse opinions. To the end of overcoming this it is now proposed to establish a United States Court of Patent Appeals to be a court of last resort on all appeals in patent cases.

From the year 1793 down to and including the year 1891 the Court of Claims passed on these matters, but by the latter date the growth of the country had been so great and the introduction of patent appeals so large that it was found to be impossible to dispose of these cases, the terms of which were of limited duration, which were running out while the cases were standing undecided upon the docket of the court. This condition was so manifestly unjust, both to the owners of the patents and to the people, that relief became necessary in some direction. This led to the creation of the United States Court of Appeals, with the right of a final appeal to the United States Supreme Court if the latter thought the case worthy of review. This has not been found entirely satisfactory, due in large part to the diversity of opinions that have occurred. Many cases have arisen in which a patent has been sustained in one court of appeals and has been vacated in another, and while there are cases in which the Supreme Court may and does reconcile these differences, yet there have been many in which it has not worked that way.

The solution of all this vexed problem seems to be in the establishment of a court of last resort to deal entirely with these matters. It is believed that this plan, if carried into execution will have the result of unifying the patent laws of the United States, of reviving the good results which flowed from the disposition of all patent cases by the Supreme Court, so long as that court heard and determined all patent cases, and of creating a single tribunal in whose hands the patent law of the United States may grow and develop, as the necessities of the future may demand, into a great, consistent, harmonious, wise and satisfactory body of rules which will be of equal value to the inventor and the public.

From either one of two standpoints—that of the inventor who is interested in having his rights quickly determined and adjudicated, so that if he is entitled to control his invention he shall know it as soon as possible, as well as from the standpoint of the public, for if the patent is invalid the public is entitled to know it in the shortest possible time, so that they may be relieved of the restraints imposed upon them by the patent—this bill would appear to be the solution of the problem.

It is of the highest importance to the people of the United States that they should know, as soon as possible, exactly what the meaning of a patent is, whether it is a good one or not, and what does and what does not infringe it. A United States Court of Patent Appeals, when established, would simplify and settle the law so as to greatly reduce the number of void patents issued.

The court, as the bill now stands, is to consist of five judges—a chief justice to be appointed by the President, and four other judges to be appointed by the chief justice of the Supreme Court, for terms of six years each, with the power of reappointment. It is perfectly evident that such a system will gather in a single court men of the highest capacity and experience, as they must already be judges before they are eligible for appointment to this office; and it would be natural to infer that this measure would result in the building up of a consistent system of patent law which would be a bulwark of the industries of the United States.

The plan is not a hastily formulated one, but it has been devised by a committee of the American Bar Association, by which it is heartily indorsed. It has already been indorsed by the Bar Association of the City of New York, the Washington Patent Law Association, Chicago Patent Bar Association, the Bar Association of the State of Oregon, Bar Association of the State of Colorado, Bar Association of the City of Denver, and the Bar Association of the City of Los Angeles, California.

Many of the just complaints which are constantly being made regarding our patent laws would be answered by this measure, the effect of which would be far-reaching and beyond anything that the layman would at first sight suppose. Present conditions are well nigh intolerable and their solution would to a large extent follow the institution of this court.

The Machine Tool Builders and the Tariff

At a special meeting of the National Association of Machine Tool Builders held in this city March 1, the following resolutions were passed:

Resolved, that it is the sense of this convention that we favor the creation of a permanent tariff commission for the following purposes:

First—The collecting and intelligent, thorough and unprejudiced study of tariff facts.

Second—The preservation and promotion of our home market and the development and enlargement of our foreign trade.

Third—The accomplishment of this by reciprocal trade agreements, based on maximum and minimum schedules.

Fourth—The adjustment of the tariff schedules so that they shall affect all interests equitably.

Be it further resolved, that a copy of this resolution be sent to the Hon. Charles M. Fowler, representative in Congress from New Jersey, who is advocating a bill of this nature.

Since machine tools are now classed with other machinery in the tariff schedule and since this action, by contemplating a special classification necessitates accurate definition of the machines to be so classed, the meeting took additional action, by reference to a committee, to formulate such definition.

The effect of the recent reductions in the price of steel was also discussed, the sense of the meeting being that the amount of steel entering the construction of machine tools is too small to justify reductions in the prices of machine tools because of the reduced cost of steel.

It is expected that the spring meeting will be held in Milwaukee in May, though the exact date has not yet been decided upon.

Draftsmen for Government Service

The War Department will, in the near future, require ten draftsmen at salaries ranging from $1600 to $1800 per annum, the selections to be made through a civil service examination. Those interested should communicate with the chief of ordnance, United States Navy, Washington, D. C.

Spring Meeting of the A. S. M. E.

Announcement is made that the spring meeting of the A. S. M. E. will be held in Washington May 4-7.

New Publications

MECHANICAL WORLD ELECTRICAL POCKET BOOK. Published by Emmott & Co., Ltd., Manchester, Eng. Cloth; 278 pages, 4x6 inches; illustrated; many tables. Price, 8 pence, postpaid.

The 1909 edition is considerably more comprehensive than the previous one. The topical scope now includes transformers, rotary converters, motor generators, three-wire balancers, boosters and electric elevators. The discussions, however, are brief to the verge of perfunctory scantiness.

MECHANICAL WORLD POCKET DIARY AND YEAR BOOK. Published by Emmott & Co., Ltd., Manchester, Eng. Cloth; 356 pages, 4x6 inches; 61 illustrations; many tables. Price, 8 pence, postpaid.

This is the twenty-second annual edition of this useful little manual, but it shows the effects of revision notwithstanding its long life. The discussion of friction clutches has been made more comprehensive, the steam-turbine section has been extended to keep abreast of recent developments, and a section devoted to chain drive has been added. The section devoted to gas power remains inadequate, as before.

SHAFT GOVERNORS; CENTRIFUGAL AND INERTIA; SIMPLE METHODS FOR THE ADJUSTMENT OF ALL CLASSES OF SHAFT GOVERNOR. By Hubert E. Collins. Hill Publishing Company, New York. Cloth; 120 pages, 4½x6¾ inches, illustrated. Price, $1.

This is one of a series of handbooks brought out by the Hill Publishing Company that should find a place in the library of every operating engineer. It consists principally of a compilation of matter that has appeared in the reading columns of *Power*, with the addition of some special articles which have been prepared to make the work a complete handbook on the subject.

Twenty-four pages in the first part of the work are devoted to a history and description of the evolution of the shaft governor. Then follow definitions and rules relating to the adjustment of the different types of governor in use in this country. Chapter 12 relates to the Curtis steam-turbine governor, and the last chapter is devoted to instructions for changing the speed of engines controlled by pendulum governors. There are thirty-five line-drawing illustrations and a complete index.

PUMPS, TROUBLES AND REMEDIES. By Hubert E. Collins. Hill Publishing Company, New York. Cloth: 99 pages, 4½x6¾ inches. Price, $1.

This is one of the *Power* handbooks prepared by Mr. Collins for the use of the operating engineer. The first five chapters deal with pump troubles and the cases cited cover nearly if not quite all the possible sources of pump trouble and the remedies. One chapter is given over to the description and illustration of some novel cases of pump repair and shows how fertility in resource in emergency is a valuable qualification in a man in charge of steam apparatus.

Two chapters tell of the methods of valve setting on duplex pumps, both simple and compound. There are also chapters upon boiler-feed pumps and horsepower of pumps in general, on pumping tar, molasses, cocoa liquor and other heavy liquid and semi-liquid substances. There are tables of pumping-engine performance and tables of various kinds of useful information. One chapter gives general directions for erecting and operating steam pumps. The work was prepared by an engineer from his experience which covers nearly twenty years of active service in engine and boiler rooms. The illustrations and index are comprehensive.

HARDWARE WINDOW DRESSING. By Thomas A. Bird. 252 7½x10½-inch pages; illustrated. The Merchants Record Company. Chicago, Ill. Price, $2.50.

The work fully lives up to its title, for it shows all of the regular lines of hardware goods arranged in representative window display. The text is good, plainly written, and still is, as it should be, of secondary interest compared with the illustrations. These are in great profusion, mainly in the character of half-tone cuts of prize or representative displays. Hardly a page of the book is without its illustrations, and some have several. To the hardware-window dresser the book should be of great value, on the score of these illustrations alone. Suggestions are given in regard to mechanical effects, by the construction of simple mechanical appliances to aid in showing particular lines, lettering, the printing and painting of signs, show cards, and the like, and the use of bunting, paper, artificial flowers, and similar materials of a purely decorative nature. In many instances the line is sharply drawn between displays that will sell goods and those that will only arouse interest. One section of the book takes up floats for use in parades, festivals and on similar occasions. The wealth of suggestions that it contains should make it of great value in the field for which it was written.

Personals*

John D. Powers, for some years past in charge of the hack-saw department at H. Disston & Sons Company, Inc., will sever his connection with that firm on March 31.

Arthur D. Hoefinghoff, who was formerly associated with his brother, Harry T. Hoefinghoff, of the Bickford Drill and Tool Company, has become sales manager of the Heald Machine Company.

Axel E. Zetterman, master mechanic, of Boston, has recently joined the forces of the Cataract Refining and Manufacturing Company, of Buffalo, N. Y., and will look after the sale of their cutting compounds in the New England territory.

Dickerson G. Baker, formerly superintendent of the Remington Arms Company at Ilion, N. Y., has recently joined the forces of the International Steam Pump Company as works manager of the Blake & Knowles Steam Pump Works at East Cambridge, Mass.

Fred J. Miller, vice-president A. S. M. E., became on March 1 connected with the Union Typewriter Company, of New York, with the title of assistant to the president. He will devote himself especially to matters connected with the manufacturing department of the company, which has factories at Ilion, Syracuse and Bridgeport.

Our occasional contributor, J. E. Johnson, Jr., of Glen Wilton, Va., has become a local hero by his holding up at the point of the revolver of a lynching party which was bent upon summary justice to a negro for the "usual crime." Mr. Johnson succeeded in saving the culprit from the mob and in having his case attended to by the courts of justice.

*Items for this column are solicited.

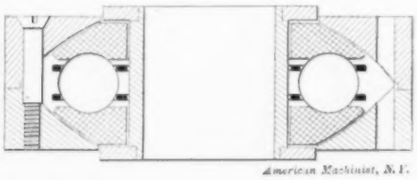
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

Thrust Ball Bearing

This bearing consists of two outer rings, held together by screws, as shown at the left, and oil holes as seen at the right, which give direct and effective lubrication. Both seats are spherical, as are the ball races, to permit of easy self-adjustment to take care of any deflection, and at the same time to distribute the thrust uniformly among all the balls. The central



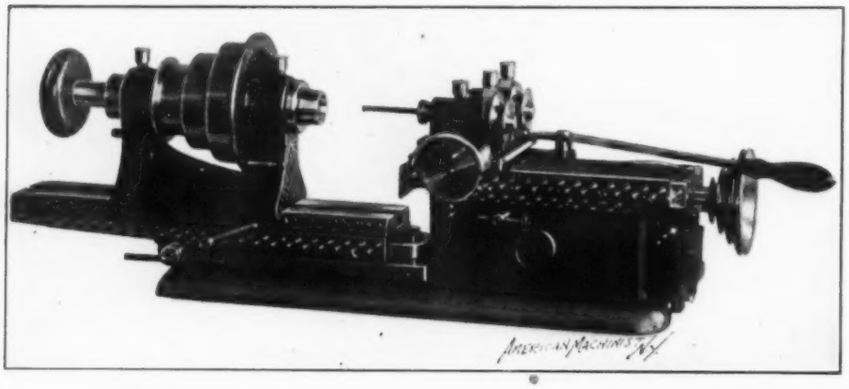
DOUBLE-ACTING THRUST BEARING

bushing carries a ring at each end, one being shrunk in place after the ball races are slipped on so that everything is self-contained.

This is known as the R B F thrust bearin, and is being supplied for worm gearing and to automobile construction by the International Engineering Company, New York City.

Small Automatic Internal Grinder

The novel features of this machine are the use of a double-friction disk drive in order to get extremely high spindle speed for the grinder at a comparatively low belt speed, and an automatic cross-feed on a machine of this size. This comes under the head of a watchmaker's tool, but handles internal grinding of any size up to 1 inch in diameter. The stroke of the traverse slide can be adjusted from 5/16 to 2 inches while the automatic cross-slide feed ranges from 1/15,000 to 1/1500 inch to each stroke of the traverse slide, and can be set to stop at any desired point.



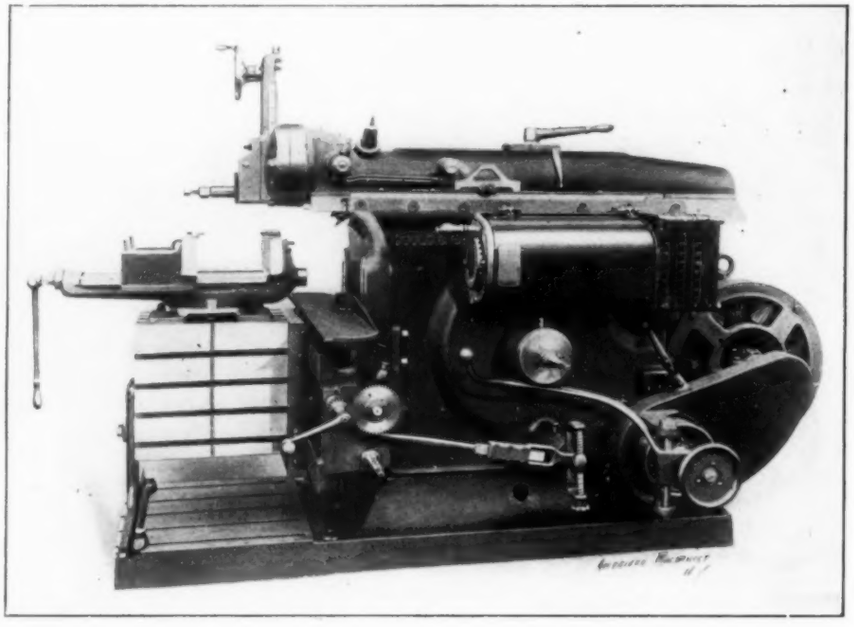
AUTOMATIC INTERNAL GRINDER

The cross-slide can be withdrawn from alinement by the lever, for ease of measurement, and is returned to position by springs.

The bed for the head carrying the work can be swiveled to 45 degrees, and each degree divided into minutes by use of a micrometer screw. The bed is made to take the regular bench-lathe head made by this firm, the Waltham Machine Works, Waltham, Mass. Those who do fine tool or die work are sure to be interested in this machine.

Motor Driven Shaper with Clutch

This shows an individual motor-driven shaper connected through a friction clutch



MOTOR-DRIVEN SHAPER WITH CLUTCH

so that the machine can be stopped quickly independent of the motor itself. The tool is a 34-inch, high-duty shaper manufactured by Gould & Eberhardt, Newark, N. J., and the motor is a direct-current, adjustable-speed, type "SA" Westinghouse, 5-horsepower. The speed may be adjusted by a drum controller over a range of 400 to 1600 r.p.m. in a series of 15 forward and six reverse steps. The latter are provided for use in making the preliminary adjustments where it may be necessary to reverse the motion of the ram.

Connection between the motor and the shaper is made by a silent-running Morse chain protected by a chain guard. The motor is conveniently located on the rear of the shaping housing which makes the outfit a most compact unit free to be located at any point in the shop. The use of the adjustable-speed motor with this wide speed range does away with the necessity for mechanical speed changes, and gives a greater number of steps than is possible by other methods.

Particular attention is called to the clutch and brake device controlled by the long curved lever, shown below the controller. By means of this the shaper may

be instantly stopped without stopping the motor. This saves time in setting, adjusting and examining the work and also lessens the wear and tear on the motor which would result if it were necessary to stop and start the motor for every little adjustment. The controller is conveniently located, and all the movements are controlled within easy reach of the operator.

An Eccentric Boring Head

Any toolmaker who has ever used an offset boring tool which had to be tapped slightly into the exact position, will appreciate the substantial and easily adjusted eccentric boring head recently brought out by the Marvin & Casler Company, Canastota, N. Y., and illustrated herewith. It consists of a chuck *A* screwed into the plate *B*, which is held in the body *D* by the retaining ring *C* and adjusted by a screw graduated to thousandths, shown in Fig. 2. After drilling the hole with a 1-inch drill in this case, the drill is replaced with a boring bar as in Fig. 3, and the hole accurately bored out to any desired size. By using a hooked boring tool the hole can be bored to almost any size.

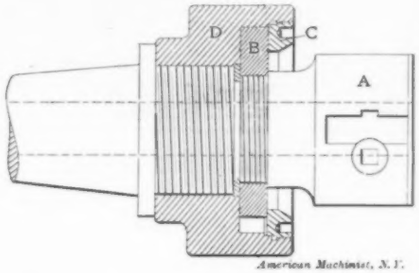


FIG. 1. CONSTRUCTION OF BORING HEAD

A hole through the chuck allows bars of any length to be used with a hollow spindle, and a large bar can be screwed in place of the chuck when found advisable. This brings it so near the spindle of the machine that it is very rigidly supported and will carry a large bar or cutter head easily.

Nor is tool work the only field of usefulness, as Fig. 4 shows the head fastened to a turret lathe with a substantial boring tool in place. The fine adjustment of the head by the graduated screw allows work to be done very accurately and in a short space of time. In Fig. 5 the head is being used in a drill press to rebore a pump-valve seat plate.

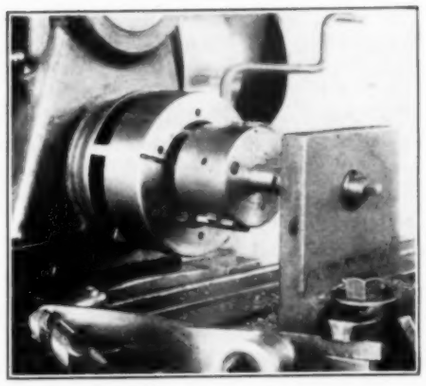


FIG. 3. ENLARGING THE HOLE

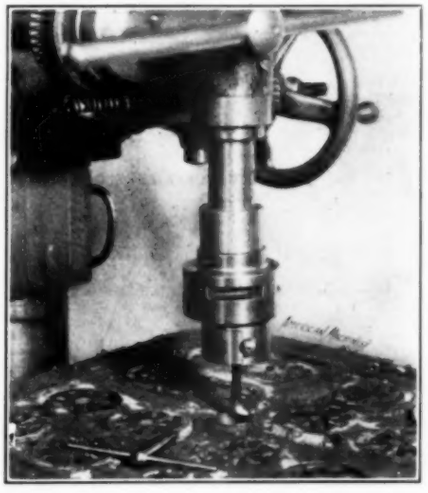


FIG. 5. USED IN A DRILL PRESS

There are many places where this head will be found very useful on account of its ease of adjustment and the wide range of work that can be done with it. It is made in five sizes, with drill-chuck capacities from ½ to 1½ inches and offsets from 3/16 to 5/8 inch.

A Compact Gear Reduction Case

The accompanying illustrations show a gear reduction case which has been placed upon the market by the Newark Gear Cutting Machine Company, Newark, N. J., for reducing and varying the speed of a small motor as required in such work as driving, annealing and hardening furnaces, tempering ovens, etc.

Fig. 2 shows it with the cover removed, with its train of gears. The motor is connected by a coupling with the worm shaft, which is made an efficient angle, to give long life. A second reduction is obtained by means of the spur pinion and gear, which drive the cone of gears; which give four different speeds to the shaft that gives out the power. A gear, pulley or sprocket wheel may be mounted upon the driving shaft, to suit the particular uses to which the machine is put.

Although but few gears are used in the case, the reduction is 1800 revolutions of the motor shaft to one revolution of the driving shaft. As four different rates of speed are obtained, these are grouped together, so that either 1, 1.5, 2 or 2.5 revolutions of the shaft are possible, by merely moving the handle which operates the sliding key in the second cone of gears. The reason for grouping the speeds, is so that the machine can be used to give several different rates of feed to the annealing, hardening or tempering conveyer,

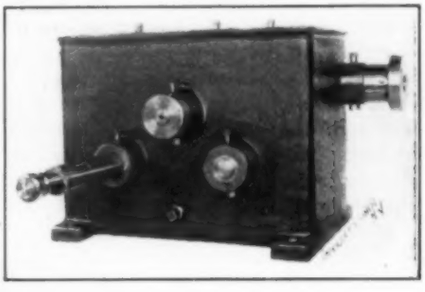


FIG. 1. GEAR-REDUCTION CASE

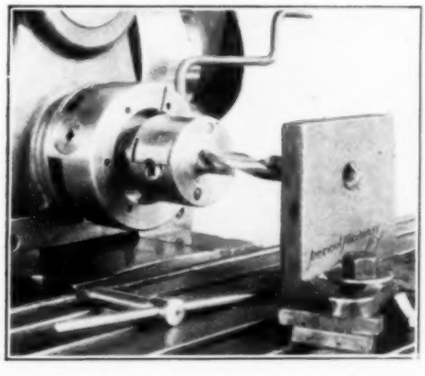


FIG. 2. HEAD CENTRAL FOR DRILLING

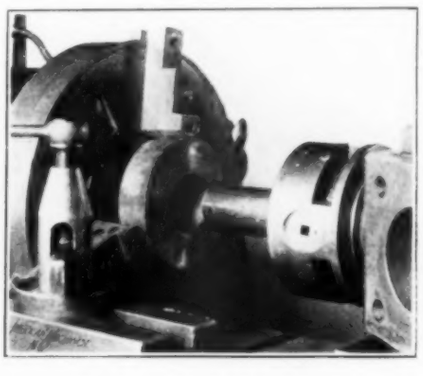


FIG. 4. BORING IN A TURRET

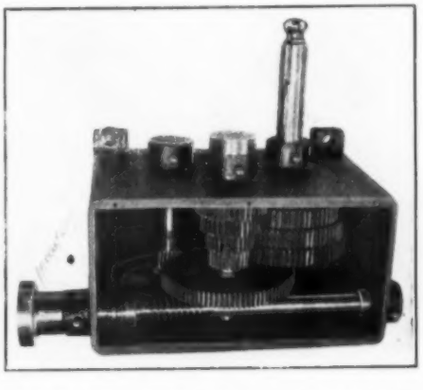


FIG. 2. COVER REMOVED TO SHOW GEARING

to suit different classes of work being treated.

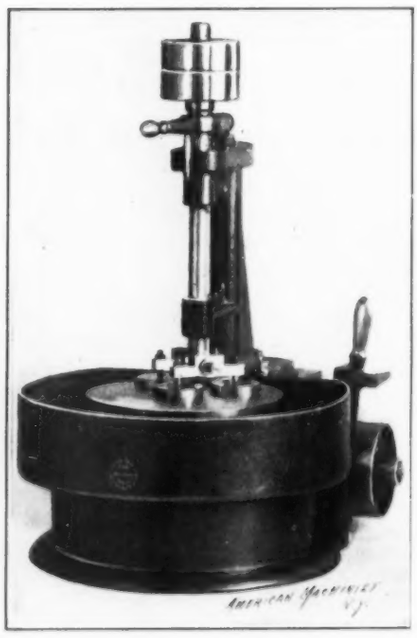
The clutch hubs of the cone of gears are all hardened, and the worm shaft thrust is taken by ball thrust bearings. Bushings are provided on the bearings of the fast running shafts. When the case is closed with its cover, it is dust proof, and the oil keeps the parts well lubricated.

This style of case is made in several different sizes, for all motor speeds ranging from 900 to 1800 revolutions per minute, and to give any of four speeds in any group that may be desired. The motor used is usually about one horsepower.

Flat Steel Grinding Machine

This type of machine is little used outside of watch shops, but deserves to be better known in the making of fine tools and similar work.

In using this machine the work is secured, usually by shellac, to cast-iron blocks. These blocks are placed under the points in the arms of the upper shaft with the work in contact with the lap carried by the lower shaft. The upper shaft travels four times as fast as the lower and in the opposite direction, thus continually changing the direction of the grinding and breaking up all lines. The necessary pressure upon the work is obtained by weignts on the upper shaft. By swinging the head carrying the upper shaft and by adjusting the distance of the points from the center



FLAT STEEL GRINDING MACHINE

of the shaft the work may be located so that exactly the full surface of the lap is covered while in operation. The lap is 12 inches diameter, and may be of glass, tin, cast iron, etc., as desired. The fineness of the finish depends upon the kind and grade of abrasive material used.

It is made by the Waltham Machine Works, Waltham, Mass.

Three Starrett Tools

The gage shown in Fig. 1 goes under several different names, such as fillet, radius, convex and concave. It is especially useful in laying out forming tools, in measuring fillets or beads and for general tool and pattern work. It is made in two sizes, one with 26 and the other with 32 leaves, the first going from 1/16 to ½ and the second from 17/64 to 1 inch.

In Fig. 2 is shown a combination taper, wire and thickness gage which combines 9 feeler gages from 0.002 to 1/16 inch, a wire gage graduated in numbers on one

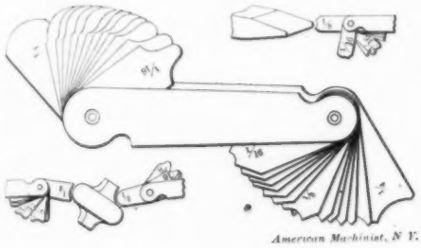


FIG. 1. RADIUS OR FILLET GAGE

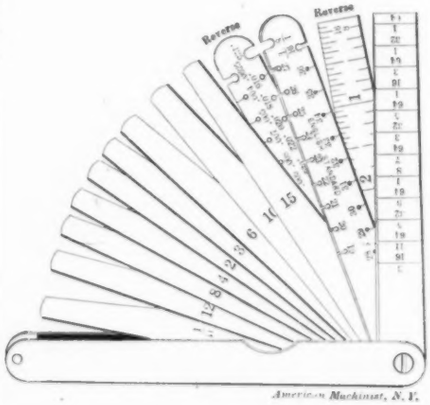


FIG. 2. FEELER AND TAPER GAGE

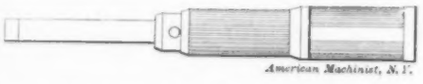


FIG. 3. MAGAZINE SCREW-DRIVER

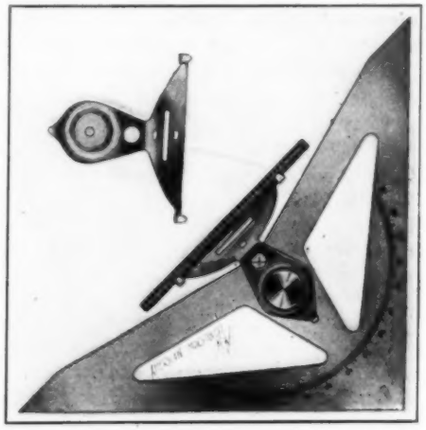
side and decimal measurements on the other, and a taper gage which should prove extremely useful. This has a scale on one side and on the other, graduations which show the thickness at that point. They all fold into a handle which is 4¾ inches long and make an extremely useful set for almost any mechanic.

Fig. 3 is an electrician's pocket screwdriver, having a ribbed hard-rubber handle. There are four blades of different widths, all carried in the telescopic handle and each locked automatically in position for use. A spring holds the extra blades in position in the handle to prevent rattling or loss when the cap is off.

These tools are all made by the L. S. Starrett Company, Athol, Mass.

Improved Triangle

The improvement consists in uniting a convenient scale to a combination angle through the medium of an erasing shield, so that all the different functions may be



IMPROVEMENT IN TRIANGLE

controlled from a single knob without interference. The scale is especially adapted for accurate work, having the front edge bent down to meet the paper. The outside scale is 4 inches long, as used on the 7-inch angle, and very light so as to be easily manipulated with the angle and is held in place under spring clips so that different scales may be readily interchanged. It is instantly placed in horizontal, vertical or angular position with little interference from ruling blades, as the angle, which may sometimes lie partly on top of the blade, is sufficiently flexible to permit bringing the scale down flat on the paper.

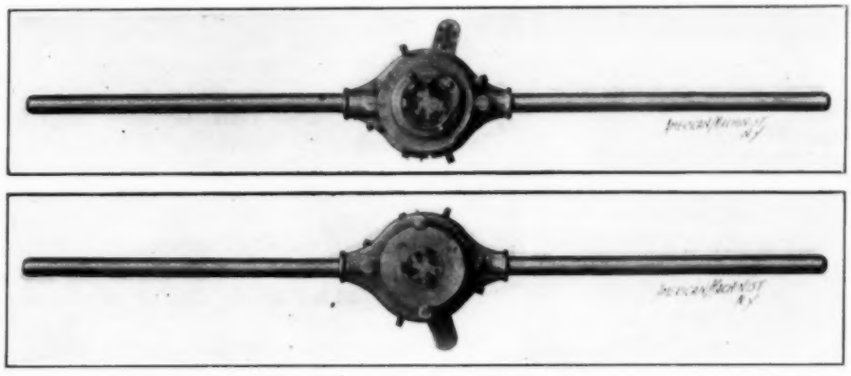
The erasing shield enables the draftsman to keep his work trimmed up sharp without the care of an extra piece. It not only preserves correct lines from needless erasure, but it prevents wrinkling the surface erased.

The outside form of the angle and the base attachment are not new, having been in use in drafting rooms for some years, but the arrangement of the protractor and the internal ruling edges for 5- and 15-degree angles are recent improvements of much practical utility in machine designing. It has been the aim to produce a tool thoroughly adapted in size, weight, manner of control and variety of application to the great majority of vertical and angular lining and petty scaling.

It is made by Duane J. Kelsey, New Haven, Conn.

A Double Die Stock

This die stock has the novel feature of containing two sets of chases, either of which can be used at will, and one set can be used for ¼- and ⅜-inch pipe while the other takes ½- and ¾-inch. A single cam changes from one set to the other and also adjusts each set to the proper size.

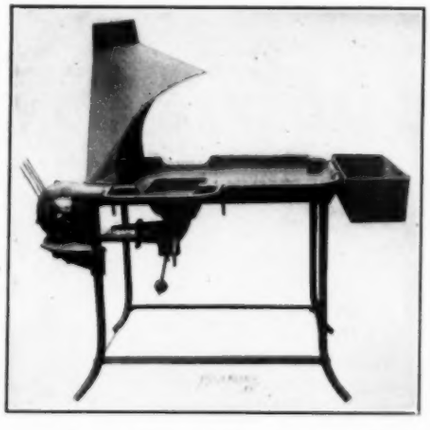


A HANDY DOUBLE DIE STOCK

It also has a cam-centering device which does away with bushings and makes it extremely convenient in many ways. It is known as the No. 6 Beaver die stock, and is made by the Borden Company, Warren, Ohio.

An Electrically Driven Forge

In the forge shown herewith a motor is directly connected to an all-steel fan which runs at 1700 revolutions per minute, the motor and fan case being securely mounted on a bracket fastened to one of the rear legs so they will always be in alinement. The only wiring necessary is a plug connection to any lamp socket, or if forge is to be permanently located wiring can be done in the usual manner. The motor regularly attached has a speed of



AN ELECTRICALLY DRIVEN FORGE

1700 revolutions per minute at 110 volts, but a motor can be attached to meet the requirements of any particular circuit.

The tuyere is of the deep-fire, anti-clinker type in which is contained a controlling ball having three openings, which allows the blast to be directed to any part of the fire bed, and also acts in conjunction with the tuyere body so as to produce a whirling effect of blast, which is desirable for all kinds of work where a quick, even heat penetration is a factor, and economy of fuel is desired. The ash valve is of an improved type, and acts on the inverted-clapper principle counterweighted by a convenient ball handle. It is made by the Buffalo Forge Company, Buffalo, N. Y.

The Cummings Multiple-spindle Drilling Machine

Large range, convenient setting and ability to secure maximum work are among the most important considerations of a multiple-spindle drill, and the machine shown seems to combine these to a marked degree.

Both the drilling head and the table are movable on the column, the head being adjustable any distance up to 15 inches by a very ingenious combination of worm wheels turning a large worm into a rack, the whole mechanism being arranged around the shaft which transmits power to the 12 spindles.

Power comes in from the cone at the back, through bevel gears to a vertical shaft in the column. From here it goes to the center of the three horizontal shafts at the top of the head. This transmits by spur gears, to the shafts on each side. These carry spiral gears and each drives four spindles through the medium of universal joints and telescoping shafts.

Each set of spiral gears is in a oil-tight case or box, turned on the outside to fit a curved seat bored in the top of the head, and can be adjusted around the horizontal shaft so as to reduce the angularity of the driving shafts and universal joints as can be seen in Fig. 1. This method of driving in sets has still another advantage as it enables the spiral gear angles to be changed so as to get a higher or lower speed on one or more spindles for special work. This is particularly valuable where one or two drills are much larger or smaller than the rest as it becomes possible to get an economical speed on them all, enabling maximum feed to be used.

The table has a feed of 7 inches, either hand or power, the screw under the table serving as a rack for hand movement. The lever shaft carries a worm wheel which meshes with the screw and another worm wheel in front of the screw is geared to the first so as to act as the other half of the nut when the screw turns, and to support the screw when it serves as a lock. A ratchet allows the handle to be moved to the most

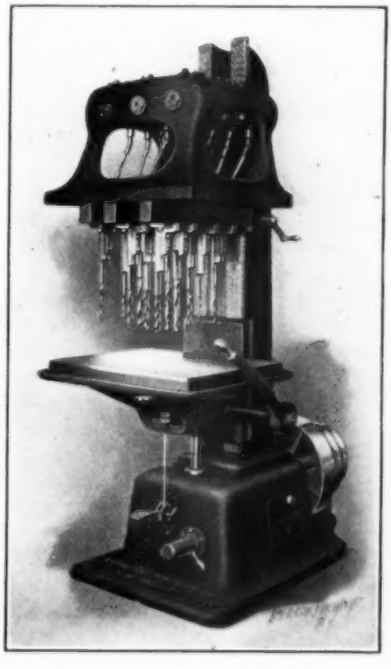


FIG. 1. WITH DRILLS SPREAD

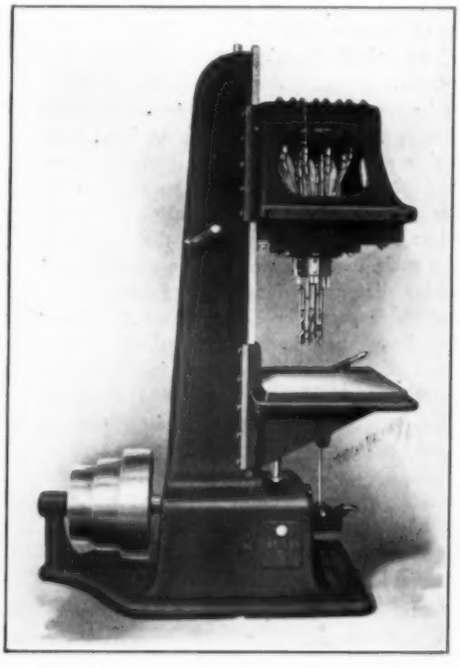


FIG. 2. DRILLS IN A CLUSTER

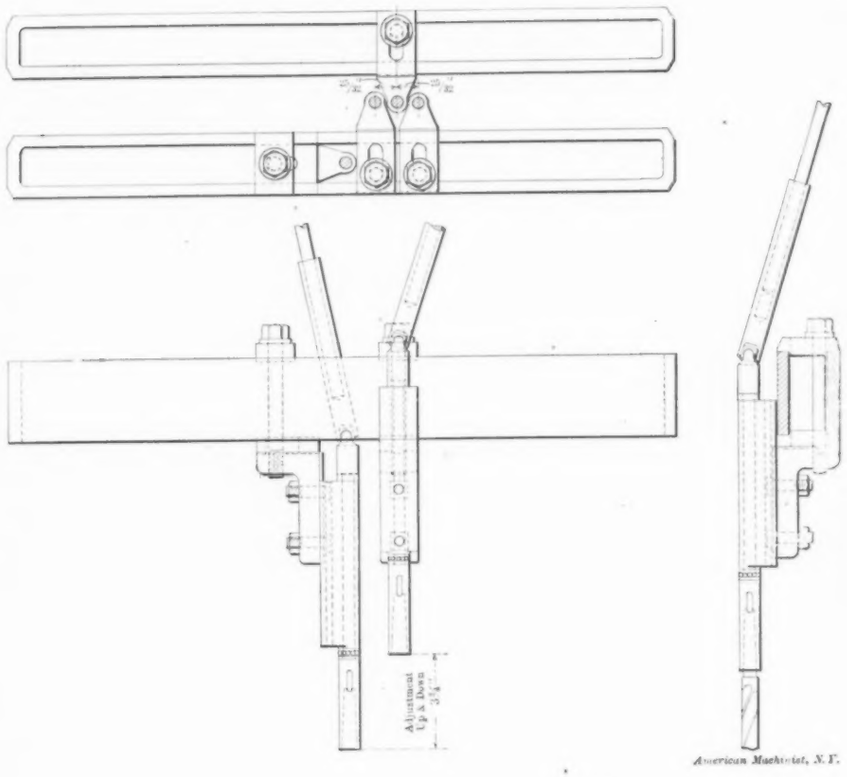


FIG. 3. DETAILS OF THE DRILL SPINDLES

advantageous position for operation. With the worm wheels stationary they act as nut for the screw, which is clutched into the feeding mechanism by pressing down the treadle shown. The rod above trips automatically and reverses the feed, lowering the table to the starting point as soon as the drills have finished drilling the holes.

The feed control is by the handle in front which has given feeds of 1, 2 and 3 inches per minute. The feed box is of the sliding-key type, locking any desired set of gears to the driving shaft.

The spindle bearings are extremely interesting because they allow the spindles to be set very close together, as can be seen from the different layouts. The general construction of these can be seen in Fig. 3, and for drills up to 19/32 inch the outside diameter is only ¾ inch, while for drills up to 15/16 the diameter is 1 inch, enabling them to be placed with center distances of only 25/32 and 1 1/32 inches, respectively. The spindle bearings also have an independent vertical adjustment of 3¾ inches to allow for different lengths of drills starting at the same time, a valuable feature when different sizes are being used. There is also a slight horizontal adjustment which comes in very handy. The bearings are of low-carbon steel, case-hardened, ground and lapped, the spindles being of crucible steel, also hardened and ground, and all have ball-thrust bearings, as have all the spiral gears.

This machine will appeal to the automobile builder on account of its wide range of work, the maximum area of spindles being 16¼x20½ inches, while the minimum dimensions can be seen from the diagrams in Fig. 4. This enables it to take in almost anything in the way of crank cases, cylinder bolts and stud holes, etc. The close spacing of the holes shown is made possible, both by the small diameter of bearings and the way in which they can be disposed on the cross rails of the head. The spindles can be bolted to either side of the rail, to the end or in the center, with the shaft through the rail, while the rails can be moved into any position.

Where a number of holes are to be drilled with very close centers, which often occurs, the spindles may be bolted to a plate and fastened to the head, as shown in Fig. 2. This locates all the spindles in the right place without trouble. This plate costs very little to make and allows rapid adjustment when the same job is to be done the second time.

The other dimensions are: Maximum distance from table to ends of large spindles, 22 inches, to ends of small spindles, 23 inches; speed of spindles, 200 to 1500 revolutions per minute; smallest circle of 12 holes, 3 inches in diameter; smallest square of 12 holes, 4⅛ inches; distance from face of column to center of head, 12 inches; area of working surface on table, 22½x28½ inches; hight of table from floor in lowest position, 34 inches; hight over all, 7 feet 5 inches; floor space, 32x52 inches.

This machine is built by the Cummings Machine Company, 238 William street, New York City.

In regard to the subject of new high-speed steels of much higher efficiency than those now in use, several references have been made to the statements of Professor Arnold. Another firm, the firm of Cammell Laird & Co., Limited, of Sheffield, England, is said to have developed and used for the past year a high-speed steel that hardens equally well in water, air and oil and exceeds in efficiency that spoken of by Professor Arnold.

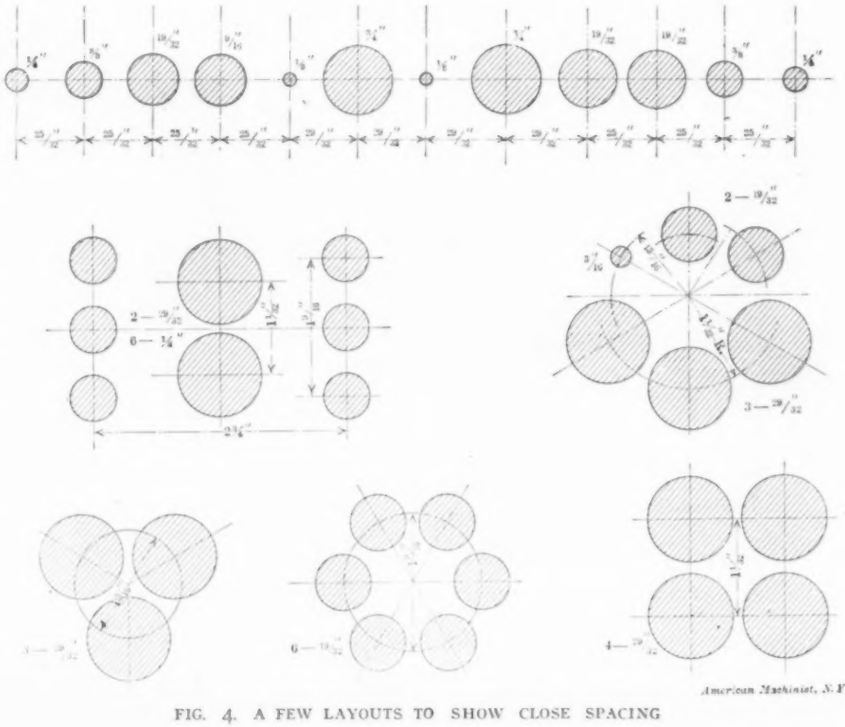


FIG. 4. A FEW LAYOUTS TO SHOW CLOSE SPACING

A Laboratory for Public Service*

A New Institution of Great Possibilities for the Development of American Industry Through the Study of Problems in Applied Chemistry

BY ARTHUR B. LITTLE

We have, as a nation, acquired the habit of being vastly satisfied with what we have accomplished. We marvel at our enterprise in scraping iron ore from the earth's surface by steam shovels, in growing wheat on virgin soil, in stripping great areas of primeval forest, in burning natural gas and allowing petroleum to spout from the ground. Even Germany acknowledges that she cannot compete with us in raising cotton, and we cut more ice in a month in the single State of Maine than all the Pictet machines in France can turn out in a year. We control the copper market of the world—because we have the copper. If you want cheap sulphur you must come to us; we pump it from the ground. We develop great centers of power distribution because our rivers run so fast down hill.

To these vast resources we have, indeed, brought a native energy, an unusual capacity for organization, and a genius for mechanical affairs. What we do, we do on a great scale, but we often do it very badly. It is quite time for us to pause in our self-congratulation long enough to inquire whether the things we are doing cannot be done better, whether, in fact, other nations have not developed and put to use much better methods, which, given equal opportunity, would put our own performance to the blush.

Although the resources of a country form the basis of its prosperity, this is, nevertheless, determined in the long run by the manner in which these resources are utilized, or, in other words, by the industrial efficiency of the means and methods of production. We have developed great transportation systems, we handle raw material on a titanic scale, we have applied machinery to the addressing of our letters and the sticking of the stamps, but it remains true none the less that with a few conspicuous exceptions our manufacturing operations are carried forward in trustful ignorance and disregard of many of the factors upon which real industrial efficiency depends. This is shown in the stupendous waste which accompanies the first crude preparation of the raw material; it is shown in the general absence of a true, selective economy in the apportionment of that raw material among the different industries, and it is shown again, and yet again, in the losses which attend nearly every step in the progress of the raw material toward the finished product. One need only refer to the wastes which attend lumbering, or the growing of flax for seed, the making of coke in beehive ovens, and the failure to utilize the casein of skim milk as a high-grade food product, to realize vaguely something of what these initial losses are. The absence of proper selective economy in the adaptation of raw material to use is everywhere, as when our railroads use untreated ties and poles, when coal-tar is burned as fuel, crystal alum used for purifying water, or valuable publications printed on ground-wood papers. We are still polluting our streams with wool grease, still wondering whether we can make alcohol from waste molasses, still buying coal without reference to heating power, and paying 65 cents a gallon for cylinder oil.

When wastes so obvious and so easily remedied are everywhere taking heavy toll of our manufacturers, it is not surprising that in all lines of productive effort subtile and elusive problems present themselves and still further lower our industrial efficiency. Steel rails break by thousands, trolley wires snap, boilers corrode, milk cans rust, unsightly bloom appears on leather, cloth is stained or tendered, paints fail to protect the metal underneath. In a large proportion of cases those who are confronted by the problem have neither the time, the training, nor the equipment required for its solution, and yet such problems and thousands of others far more complex upon their face must be solved if our industrial efficiency is to be brought to its proper level.

No one at all conversant with the facts can doubt that our industrial salvation must be found in a closer alliance and coöperation between the scientific worker and the actual agencies of production. Such coöperation exists, as we are all beginning to learn, in Germany, and its results are evident throughout the world in the tremendous expansion of German industry. In our own country no agency has done more to supply the little leaven which may yet leaven the whole industrial lump than the Massachusetts Institute of Technology, and her graduates, by hundreds, are doing yeoman service in the development of our resources and the application of the scientific method to our practice. So far this is altogether as it should be, but in the present condition of our manufactures it is by no means enough. The time has come to bring the splendid scientific organization and equipment of the institute to bear directly upon our industrial problems as an aggressive force working for their solution.

Since all material is subject to chemical laws and its properties and behavior influenced or determined by these laws, it follows that a large number, probably by far the greater number, of our industrial problems are problems in applied chemistry. No better field for the initiation of work intended to be directly effective in its bearing upon industrial efficiency could therefore have been chosen by the institute authorities than that of research in applied chemistry upon some basis which renders the results obtained immediately available to those responsible for the conduct of industrial affairs.

That the Massachusetts Institute of Technology has found it possible to lead her sister institutions in the establishment of the Research Laboratory of Applied Chemistry is due to the generosity of Charles W. Hubbard, Esq., in supplying the funds required for the initial organization and beginning of its work.

The general object of the laboratory is that of increasing the efficiency of industrial effort by carefully focused and directed research in chemistry as applied to particular phases and problems of actual practice, but what gives the laboratory its unique position is the relation in which it aims to stand to industry throughout the country. It will, so far as possible, be made a clearing house for problems in applied chemistry. Many of the expected problems have doubtless been already solved elsewhere, others may at the time be engaging the attention of outside specialists. In the one case the solution will be immediately forthcoming, in the other the laboratory will endeavor to bring the applicant into touch with those studying the problem in other laboratories. There will remain, however, many problems of wide importance in their bearing upon industry, and from among these the laboratory will select for its direct attack as many as its funds permit, giving preference always to those which promise in their solution to prove of greatest benefit to the community. Without attempting to indicate the lines along which this public service of the laboratory may develop, one may, by way of illustration, point to such subjects for investigation as the cause and prevention of the corrosion of lead pipe, the breakage of steel rails, the waterproofing of cement structures, the utilization of wastes which now involve nuisance, the study of the atmosphere of street cars and the conditions underlying

*Abstracted from the Technology Review of the Massachusetts Institute of Technology.

proper ventilation, the relation of material and treatment to the brittleness of pottery, or the fireproofing of theater scenery.

All this, so far as it relates to the Research Laboratory of Applied Chemistry, does not mean that the laboratory will not welcome problems which have a specific and limited application to particular industries; for it is through problems of this class that the laboratory will be brought into closest touch with industry and enabled to make its influence most directly and immediately felt by those whom it would benefit. No propaganda preaching the industrial value of research will make converts half so quickly as the actual solution of the particular problems by which the individual manufacturer is confronted and perplexed. For these reasons, no less than for the more compelling fact that it is to the manufacturers thus aided that the laboratory at this stage of its development must look for its support, a large proportion of its work will be directed along lines suggested by the manufacturers themselves and leading, if successful, to their individual benefit.

The new laboratory will constitute a division of the Department of Chemistry and Chemical Engineering, of which Dr. Henry P. Talbot is the head. To his foresight, breadth of view, and strong support must be attributed much of the promise of its scope and plan. The immediate direction of the laboratory and responsibility for its results will be, however, in the hands of Dr. William H. Walker as director of the Research Laboratory of Applied Chemistry.

Dr. Walker has selected as his research associates Dr. Warren K. Lewis and Dr. William Guertler. In addition to the research associates, who form the nucleus of the organization, the laboratory staff already includes two half-time assistants, who also devote themselves to instruction, and three advanced students working for higher degrees.

The laboratory is at present located on the fifth floor of the Pierce building, where quarters barely sufficient for its immediate needs have been secured by rearrangement of the space devoted to other work. No prophetic vision is required to see this space outgrown or to follow the development of the laboratory to the point where its necessities and the demands of manufactures upon it will require a separate building and elaborate special equipment.

As the laboratory gains the confidence of manufacturers, their own facilities for experiment upon the large industrial scale will naturally be placed in increasing measure at its disposal. It is not too much to hope that the relations thus established may ultimately lead to the equipment and maintenance of many small special laboratories, all under the direction of the research laboratory, but each situated at the point of best study and attack for a particular industry, as at Gary for iron and steel or in the Lehigh valley for cement. The possibilities for teaching industrial chemistry along altogether new lines and to incomparably better purpose which such a scheme of development holds out deserve the careful study of every friend of industrial education.

The recognition of the importance of the work of the laboratory and its promise of helpfulness has been so prompt and general that already the need for additional funds has become imperative, if even the immediate opportunities are to be seized. The work now under way, which is of the first importance to several of our great industries, includes the study of case-hardening as applied to special alloy steels, an investigation into the cause of the "gray sheets" which, because of brittleness, are the occasion of heavy loss to makers of galvanized iron, and a study into the causes determining the presence of pinholes in sheet tinplate. The direct bearing of this last-named problem upon the canning industry, the economy of milk transportation, and the permanence of tinned roofs everywhere is obvious. That all will ultimately be solved cannot be doubted in view of the gratifying progress already made.

The terms upon which the services of the laboratory are offered to manufacturers are these:

The laboratory will undertake a specific problem and engage to direct its best efforts toward its solution. The institute will furnish laboratory facilities and the cooperation of the general instructing staff in a consulting capacity. This phase of the arrangement is of the first importance, since it means that the facilities and organization of the mechanical and electrical laboratories of the institute, as well as those of the research laboratory of physical chemistry are available for the special assistance they can render in particular aspects of the work.

Reports of progress will be made every three months. The applicant who consigns his problem to the laboratory undertakes to pay the actual time cost of the one or two experimentalists actually engaged upon the work and the cost of special apparatus, but he is free from all expense involved in the direction of the work, or which might otherwise result from the expert consulting service of members of the instructing staff not directly connected with the laboratory. When results have been obtained the original applicant has his option of two courses: he may either permit the institute to publish the entire investigation for the general good of the community, or he may elect to keep the results for his own benefit—either as a secret process, or by having them patented in his behalf—by paying to the laboratory for its purposes of further research a sum to be agreed upon at that time.

One has only to consider in the most casual way the opportunity of the laboratory, to have technical-research problems which have their basis in chemistry crowd upon the mind. Our cities are submerged in smoke; our roads are disintegrating under the action of the automobile; we deplore the destruction of our forests, and overlook the sources of paper stock everywhere at hand; we base the future of our agriculture on the diminishing supply of Chile saltpeter, while the nitrogen of the air is pressing with the weight of many thousand tons upon each acre; our peat deposits lie untouched, while we contemplate as best we may the failure of our coal supply; we erect great structures of reinforced concrete, knowing little or nothing of the ultimate mechanism which determines the setting of the cement and still less of the factors upon which the life of the reinforcing steel rods depends. It is with such problems and many others like them that the research laboratory of applied chemistry has to deal. It will deal with them not only with the prospect of their solution, but upon a basis which holds out the promise of the gradual development of general research methods for attacking the multitude of other problems in applied chemistry wherever they may arise. Best of all, the laboratory affords an opportunity for the training of men for other laboratories, in which these methods will be applied to the solution of the problems of manufacturers and public-service corporations everywhere. Simultaneously with this training of picked men will go forward advanced courses in the application of the chemical method to the needs of industry and seminars on general subjects in chemical technology which will be open to adequately trained students upon election.

No one at all familiar with the conditions under which thousands of American manufacturers are working can fail to realize the unique and fruitful opportunity which spreads out before the laboratory, nor can they doubt that the funds for its development will be forthcoming. Within the last few years there has opened out to the worker in applied chemistry a new horizon with a sweep so broad that it is seen to include far more than the mere material gains which come from more efficient effort. It has come to be recognized that the lives of great masses of the community are constricted and confined and often mean and sordid, because our industrial efficiency as a people is still far below what it ought to be. Any general moral or spiritual uplift must find its basis in the increased efficiency of the worker, and in this stage of our industrial development no agency is more directly available for increasing this efficiency than that afforded by chemistry as applied to industry. Every waste that is prevented or turned to profit, every specification which gives a better control of raw material, every problem solved, and every more

effective process which is developed makes for better living in the material sense and for cleaner and more wholesome living in the higher sense. It means much to the material and more to the higher well-being of German workmen that their nation now controls the coal-tar industries, the manufacture of fine chemicals, and the markets of the world in many other lines, chiefly as the result of the application of the scientific method to the problems of production. The general application of these methods will mean even more to our own country.

The advantages of ball bearings for fans over plain white-metal bearings was recently determined in a series of tests referred to in an English contemporary of a 35-inch exhaust fan so designed that it could be operated either with the plain or ball bearings. When adjusted for the same volume and conditions of delivery, it was found that slightly over 7 per cent. more power was required to operate it with white metal bearings than with the ball bearings, while, when adjusted for the same power inputs in either case, an increase of delivery capacity of over 7½ per cent. was secured with the ball bearings in use.

A 14-foot Center Lathe

Owing to the rapid development of steam turbines, especially for the propeiing of vessels, the machine tools required for the construction of these engines have had to undergo considerable alterations resulting in a quite unexpected increase of their dimensions.

The lathe shown has been recently constructed by Ernst Schiess, of Düsseldorf, Germany, and is mainly remarkable for its huge dimensions. The hight of center is 7 feet and the distance between centers is nearly 57 feet, so as to allow the very largest Parsons turbine shafts up to 150 tons in weight to be handled on this lathe.

The face plate of the lathe is operated by an 80-horsepower, 15-stage motor with six gear changes, thus allowing 90 different speeds of revolution to be obtained. The drive comprises a safety device calculated to avoid the breaking of any vital parts in the case of accidents.

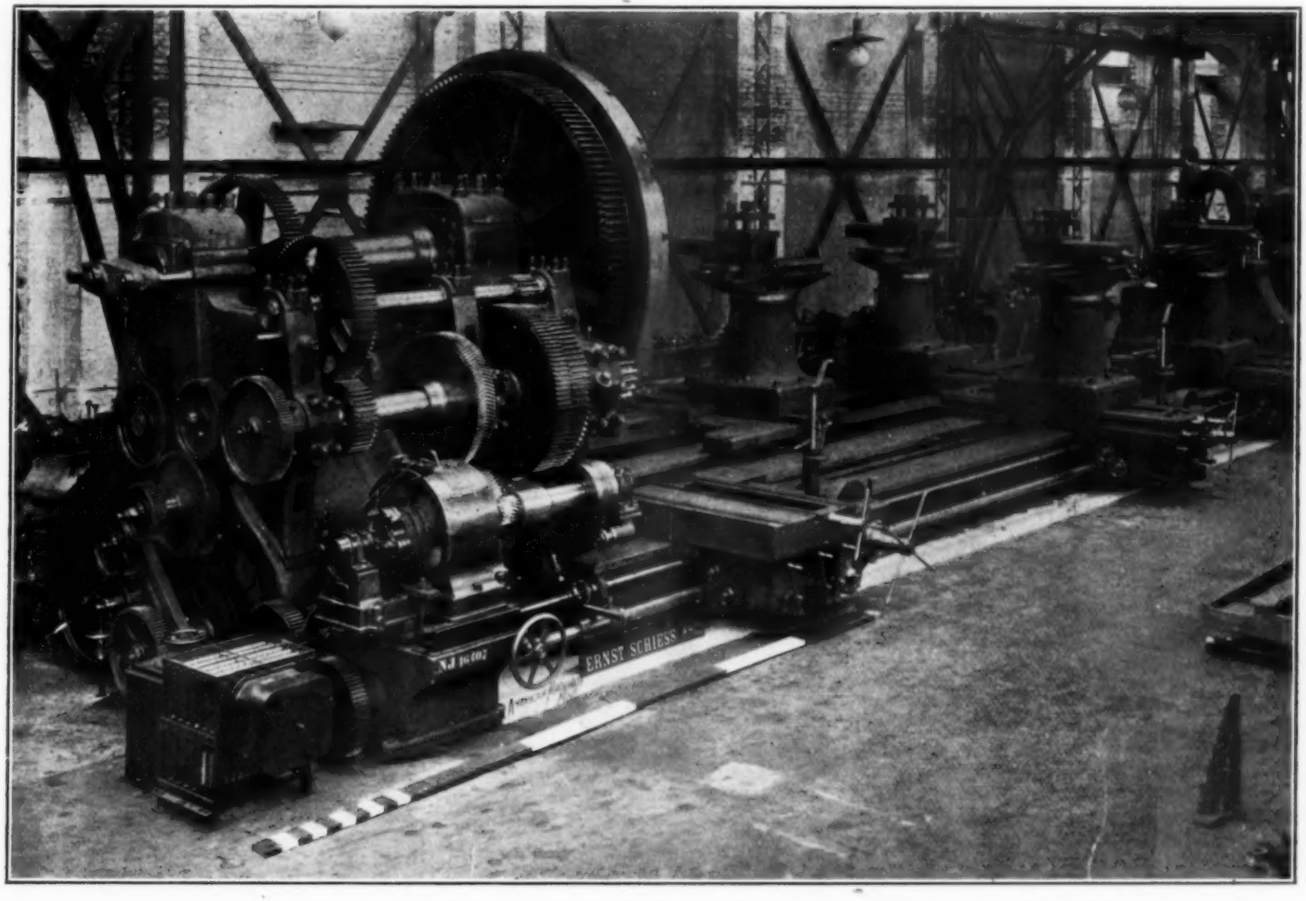
The lathe is provided with five very substantial carriages, three being on the front and two on the back side of the four-way bed, and allows any work included in the turning of turbine housings to be performed. The carriages can be adjusted rapidly by power in any direction required. Threads can be cut at any part of the work between the centers of the lathe.

A sixth carriage or puppet not carrying a tool post can be moved to any part of the bed, the operation being by hand, which, owing to the ratio of gearing, is very easy. We understand that a similar lathe with a somewhat greater swing is under construction.

Making Steel Stamps

By C. A. Coppack

Concerning the article "The Making of Steel Stamps," by P. E. Noyes, on page 956, Vol. 31, Part 2, it seems to me that there is no reason why these punches should not be made by machinery. There are machines made in this country, aye, in this town which will do such work. The question is which is the cheaper method? I know of a firm who can turn out an average of 60 punches per machine in 10 hours, with an apprentice who had no previous experience on the machine. This output was averaged right from the start.



A 14-FOOT CENTER LATHE

Some Jigs and Fixtures

By Ethan Viall

During a recent visit to the Chuse Engine and Manufacturing Company, Mattoon, Ill., I saw the various devices described here.

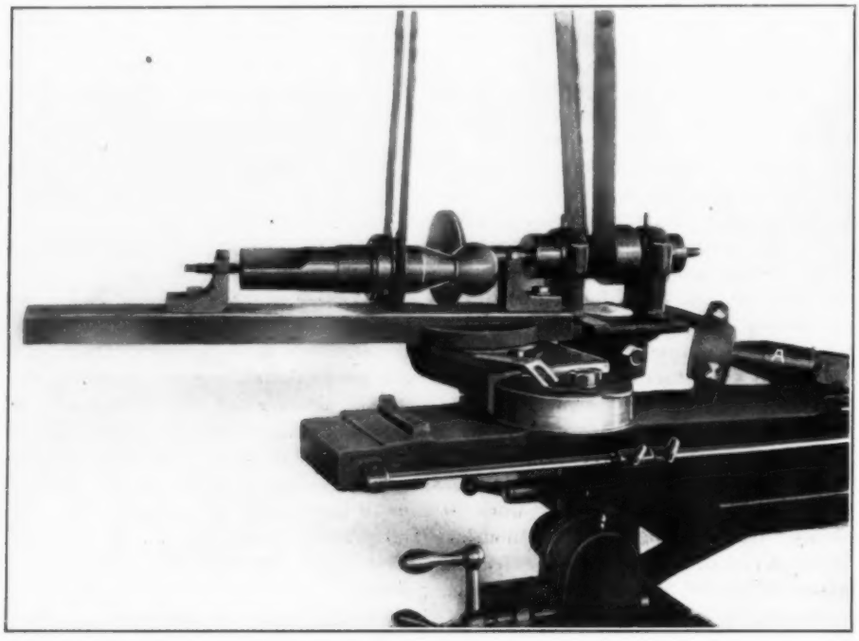


FIG. 1. THE BALL GRINDER

The toolroom contains many interesting mechanical devices, one of the most noticeable being the ball-grinding attachment they have made for their grinder. With this attachment, shown in Fig. 1, steel balls of any size, for their ball and socket attachments, may be ground quickly and perfectly true. A special collar and pulley is slipped over the ball shank to drive it, as shown, and the surface of the ball is ground by swinging the armlike attachment, on its base, by hand. The stops shown bolted to the top of the base prevent the arm being swung too far either way. A finished ball, in its brass socket, is shown on the grinder table at *A*.

A neat little jig for indexing and drilling spanner holes in stuffing-box nuts is shown in Fig. 2. Before this was made, it took about thirty minutes to lay off and drill a nut, while now the average time is three minutes each.

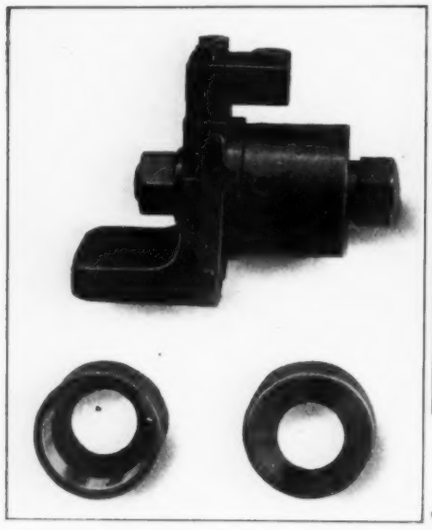


FIG. 2. CAPSTAN NUT JIG

In Fig. 3 at *A* is shown a fixture to be used on the grinder for grinding both inside and outside gages. Both ends may be ground at one setting with little chance of springing out of shape. At *B* is another grinder attachment for holding the cutters used in the keyseating machines. When placed in this, the cutters may be ground straight and of the proper bevel without any trouble.

D is used to hold thread tools while grinding. The upper half of the base is graduated and may be set to the right or left at whatever angle is desired, the tool being tilted to give it clearance.

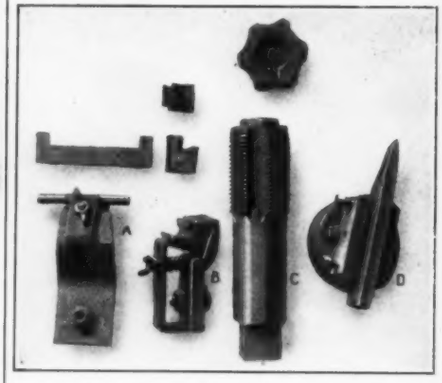


FIG. 3. GRINDING JIGS AND A TAP

A good method of making large taps is shown at *C*. This is the same as the way the common shell reamers are made, the shank being of machine steel and the cutter or shell of carbon or high-speed steel. The ones shown are made of Blue Chip high-speed steel and the saving in the cost by making them this way is considerable.

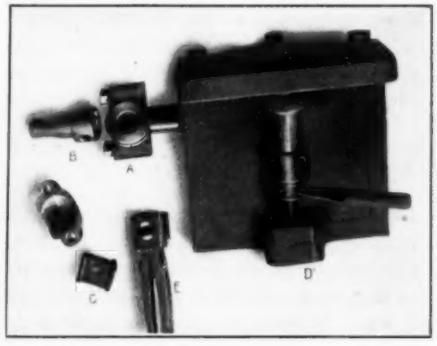


FIG. 4. SOME DRILL JIGS

The jig used to hold the two halves of the brass sockets, used for their ball and socket parts, while drilling the cap-screw holes, is shown in Fig. 4 at *D*.

The blocking used when drilling the cap *A* is shown at *B*. *E* is a tong drilling jig, for holding the part shown at *C*. The idea for this was obtained by Mr. Reich, from the American Machinist, several

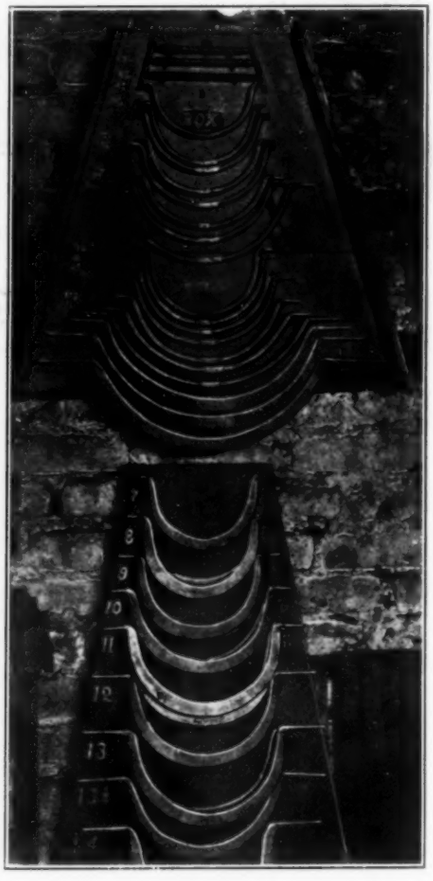


FIG. 5. GAGES

months ago. The way some of the gages used here are made and kept is shown in Fig. 5.

Fig. 6 shows the snap gages used in sizing engine eccentrics, and the method of keeping them so they are not liable to injury.

Fig. 7 at *A* shows a "third leg" which Mr. Reich has put on the shop center gage for grinding centers and center punches. This third leg prevents tipping

FIG. 6. GAGES FOR ECCENTRICS

of the gage and consequent inaccurate gaging. *D* shows a special center punch used to compress the metal around the center hole countersink for heavy work, the sleeve being used to keep the punch perfectly true as it is hit with a hammer. *E* shows the style of finishing reamer used on part *B*.

C is a special lathe dog with brass cups used to clamp on the ball of part *F*, while the threads are being cut. Out in the machine shop is a machine made by the Dreses Machine Tool Company, Cincinnati, that is the only one of its kind I

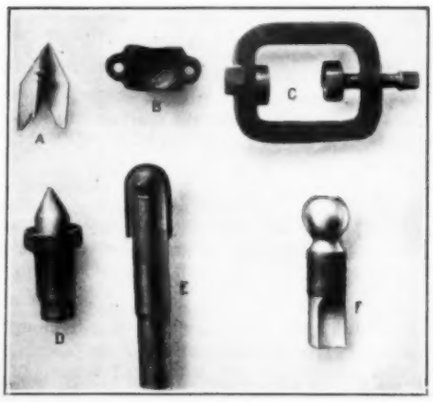


FIG. 7. SOME SMALL TOOLS

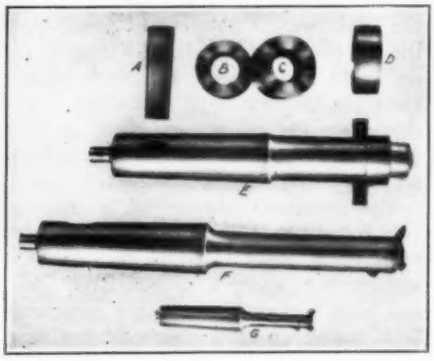


FIG. 8. TOOLS USED IN BORING MACHINE

have seen in the middle West, though its usefulness and convenience are readily seen. This machine is a heavy drill press, fitted with a traverse table. Pieces may be drilled, reamed, tapped and the bosses faced off on both sides at one setting, and holes may be made in line, up to the capacity of the traverse motion, with the assurance that the holes will be at the same angle and perfectly in line, if so wanted, or they may be offset at right angles without changing their perpendicular truth.

The counterbore, or facing tool, used in this machine, is shown in Fig. 8, *A* being the key used to fasten it into the spindle when facing the lower side of bosses. The spindle of the machine has two holes in it, one being the usual drift hole, and the other for a key. In making tools for this machine the taper shank is sized up and inserted in the spindle and the keyhole marked with a scriber and then drilled

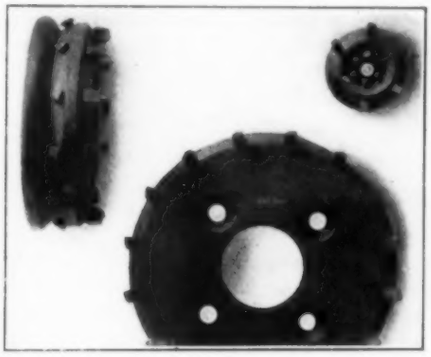


FIG. 10. CUTTER HEADS

and filed out, allowance being made so as to give a slight draw as the key is inserted.

B C D in Fig. 8 are pilot bushings or tool supports, according to the way the tool is used. Figs. *F* and *G* are boring bars, the method of holding the cutter, here shown, allowing a cut to be taken clear to the bottom of a hole. The large one is also fitted with a keyhole like *E*.

Fig. 9 is a slab miller built by Superintendent Chuse, when just out of school. The bed was taken from an old Betts planer, but the rest was made in the shop. This machine was finished in 1899 and

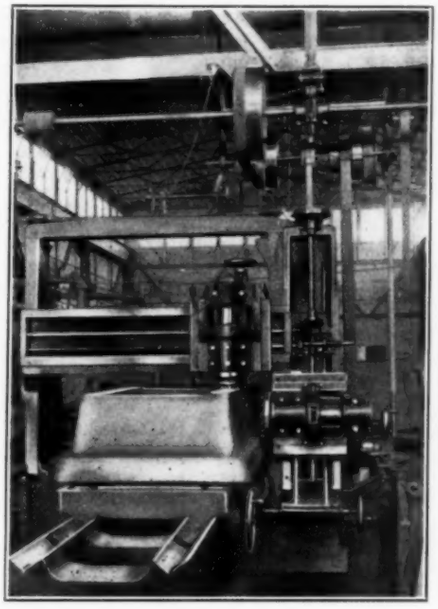


FIG. 9. A HOMEMADE SLAB MILLER

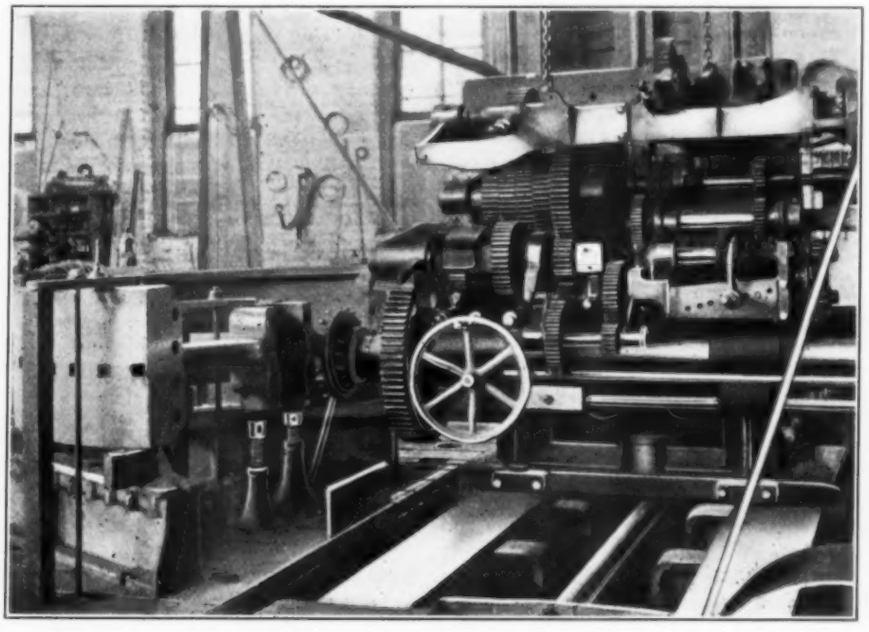


FIG. 11. MILLING A BIG FLYWHEEL

has been in continual use since. The housings and cross rail allow a hight of 36 inches and a width of 63 inches, the bed being 9 feet long.

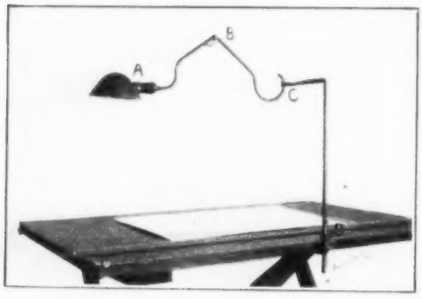
Fig. 10 shows end and side views of the type of inserted-tooth milling cutters used on this machine. These cutter heads are held in a universal fixture when grinding, the indexing being done by a spring stop set against the face of the tooth being ground. The small cutter head shows the position of the cutters and set screws allowing a cut to be taken up against a shoulder or into a corner.

Fig. 11 shows the method of milling pulleys, flywheels and work of that class. Engine beds of all sizes are also machined in this machine.

Drafting Table Light

By C. J. Mitchell

About two years ago we were gladdened by the news that the directors had voted money for a new office building. Immediately the drafting department went into a committee of the whole as to the ideal equipment of a drafting room. The combined talent evolved several details which we have since enjoyed. Probably



A DRAWING TABLE LIGHTING FIXTURE

the one which has given us the best satisfaction has been the lighting.

Our location is an isolated building with plenty of room around it and ample window area. The building is but 42 feet wide, so we do not need artificial light on our folio tables in the center of the room, or on the drawing tables, each one near a window, until late in the afternoon on ordinary days in the winter time.

For artificial lights we considered the inverted arc and the mercury lamps; but we did not adopt either method for two reasons: First, the cost of installation and, second, the cost of maintenance. The system adopted consists of 16-candle-power lamps, placed in two-light chandeliers in a line in the center of the room 8 feet apart. These afford ample illumination for referring to the folio prints on the tables in the center of the room, and for general illumination. In the ceiling on either side are placed sockets 8 feet apart each way; the windows are spaced 8 feet centers and the sockets are so placed that wire for the drawing-table light hangs nearly vertical when the light is in a convenient location. The second row from the wall furnishes connection for the single light with reflector, which hangs directly over the center of the draftsman's reference table. The third row of sockets is for another row of drawing tables when required.

The cut illustrates our table light and its several points of adjustment. The cord leading to the light has a coupling, not shown; this is located about seven feet above the floor, making a convenient point of disconnection when the janitor wants to scrub, or when the whole lamp is taken off. The joint *D* consists of a small brass casting fastened on the underside of the board, and provided with a clamp to hold the stand in a fixed position, this we do not find of much use; the set collar on the stand is used to fix the hight of the lamp, and after adjustment for the individual draftsman is not changed. The collar serves as a very convenient joint to swing the standard, and all, to the back of the board.

The standard is made of a piece of cold-rolled stock bent with end up, set to form the joint *C*, which consists of a straight hole about 1/32 inch larger than the brass tube; this makes a very neat joint for adjusting the hight of the lamp, easily handled, and also permitting of swinging horizontally. The tube is bought from standard stock and contains the joint *B*, which permits of vertical movement, and contains a clamping screw to hold the proper position for the individual draftsman. This clamp is not often reset. The lamp is covered by an aluminum shade of parabolic shape, which does away with the "bright spot," so much in evidence with the conical reflector. Of course, the reflector can be twisted to throw the light where wanted.

The advantages over our old lighting are: 1. One light is sufficient for each man, it being readily shifted from place to place over the board with one hand. 2. Absence of strings to hold the lamps where desired. 3. No light in the draftsman's eyes; all the light is on the work. 4. The tables can be shifted to suit individual tastes to a considerable extent. 5. Ease with which the lamp can be adjusted to suit individual taste, there being, now, practically no suggestion of improvement, whereas formerly we had to readjust the suspending cords frequently.

Harvlin Paddock

Harvlin Paddock, an important employee with the Fairbanks Scale Company, St. Johnsbury, Vermont, died on March 2, at the age of 77 years.

When but a young man Mr. Paddock took up employment with the Fairbanks Company and remained with them fifty-three years. His specialty was preparing and hardening steel for scale pivots, using a process which he introduced. He had charge of the company's experimental department for many years, during which time he introduced and patented many improvements in scale construction.

He was an especially public-spirited man and gave much time and effort in the interest of St. Johnsbury general welfare.

Business Items

The Wagner Electric Manufacturing Company announces the appointment of Edwin H. Cheney as manager of its Chicago district, with headquarters in the Marquette building, Chicago, Ill.

Peter A. Frasse & Co. announce that on or about April 1 they will remove their office and salesroom to 130 and 132 Worth street, New York City, which will afford them large accommodations.

The Picrome Hide Company, of Syracuse, N. Y., manufacturer of quride and metal gears, has appointed G. R. Whitehill, 614 Chestnut street, Philadelphia, Penn., agent in territory of Philadelphia and vicinity for gears and general agent for its railroad business.

The formal opening of the new demonstration room of Marshall & Huschart Machinery Company, Chicago, Ill., at 62 South Canal street, took place on February 20 and was largely attended. The Superintendents' and Foremen's Club of the Chicago branch of the National Metal Trades Association held its regular meeting in the room on that date.

Business Opportunities

The East Moline (Ill.) Sash and Door Works will build an addition to plant.

It is reported the Buckeye Ditcher Company, Findlay, Ohio, will enlarge plant.

The Lindsey Wire Fence Company, Collinwood, Ohio, is building a new factory.

The Eaton Rapids (Mich.) Furnace Company is making arrangements to enlarge plant.

The Virginia Bridge and Iron Company, Roanoke, Va., is building an addition to plant.

The Dayton (Ohio) Motor Car Company is planning the erection of a large addition to plant.

A. Bowie, Elkwood, Va., is organizing company to establish machine shop for general repairs.

A. O. Kehm Casting Company, Birmingham, Ala., will erect foundry for the manufacture of heavy castings.

The H. W. Johns-Manville Company, of New York, is to rebuild plant at Milwaukee, Wis., recently burned.

The Warner Gear Works, Muncie, Ind., is to erect an addition to be used as a molding and finishing department.

The Burt Olney Canning Company, of Rome, N. Y., and elsewhere, will establish another plant at Medina, N. Y.

Plans are being made for a new factory for the American Rubber Reclaiming Company, at Germantown, Penn.

Contract has been awarded for construction of a $10,000 factory for the General Gas Mantle Company, Camden, N. J.

The Purvis Iron and Machinery Company, Philadelphia, Penn., is having plans prepared for a new factory building.

It is reported that the Virginia & Southwestern Railway will enlarge shops at Bristol, Tenn.-Va. J. H. McCue, Bristol, manager.

Wolstenholme & Clarke, worsted yarn manu-

facturers of Manayunk, Penn., has bought site for a new plant in Philadelphia.

It is announced that the Erie Railroad Company will expend over $400,000 in building new car shops at Hornell, N. Y.

The French Manufacturing Company, Waterbury, Conn., manufacturing brass and copper tubing, is building a new factory.

The Corrugated Bar Manufacturing Company, of St. Louis, Mo., will move to Youngstown, O., where new plant will be erected.

Engineers' Specialty Company, Kansas City, Mo., will erect factory for the manufacture of lubricators and machinery supplies.

R. E. Duff and J. M. Charters, of Tacoma, Wash., will build a factory in Vancouver, Wash., for the manufacture of wooden pipe.

The Ashworth & Odell Worsted Company, Jamestown, N. Y., has secured site on which a new and larger mill will be erected.

L. A. Pitts, Dubuque, Iowa, will erect a foundry in South Houston, Texas, for the production of railroad and machine castings.

Barnhart Bros. & Spindler, Chicago, Ill., have purchased site for a new plant for the manufacture of type and printing machinery.

It is reported that the United States Steel Corporation is to build another city like Gary, Ind., on the St. Louis River, near Superior, Wis.

The J. P. Paulson Company, Denver, Colo., is to erect a branch plant in Salt Lake City for the manufacture of office furniture and bar fixtures.

The Southern Pacific Railway Company is making arrangements to start building machine shops and roundhouse at Santa Barbara to cost about $100,000.

The Missouri, Oklahoma & Great Northern Railroad, it is said, will erect machine shops near Sherman, Tex. E. J. Noonan, Muskogee, Okla., is chief engineer.

It is reported that the Chas. A. Wortham Company, of Dayton, Ohio, contemplates establishing a branch plant in Montgomery, Ala., for manufacturing woodenware.

The plant of the Cascaden Manufacturing Company, Waterloo, Iowa, was destroyed by fire, causing a loss of $15,000. The company manufactured stoves and gasolene engines and did a general foundry business.

The Atlantic Furniture and Lumber Company, Lineville, Ala., will erect plant for the manufacture of beds, dressers, etc., and lumber. $10,000 worth of machinery is to be installed.

The Huntsville (Ala.) Business Men's Club is negotiating for the establishment of a large foundry and machine shop to supply demands of southern cotton mills for all kinds of repair.

The Sageng Threshing Machine Company, Minneapolis, Minn., has purchased plant which will be remodeled and equipped with machinery for the manufacture of its threshing machine.

The Bullard Car Door Equipment Company, Birmingham, Ala., recently incorporated, will establish plant for manufacturing car door equipment patented by R. G. Bullard, who is president of the company.

Under schedules 936, 939, the Bureau of Supplies and Accounts, navy department, Washington, D. C., will open bids on March 2 on leather belting, engine counters, gun forgings and a valve reseating machine.

The International & Great Northern Railroad Company has selected site at Taylor, Texas, on which to build machine shops and roundhouse to replace those burned some time ago. O. H. Crittenden, Palestine, Texas, chief engineer.

The American Steel Dredge Company, Fort Wayne, Ind., is being formed with a capital of $150,000 by J. C. F. Sprankle, W. A. Bohn, C. C. Schlatter and others for the purpose of engaging in the manufacture of dredging machinery.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., March 8, for band saws, twist drills, pipe dies, drill chucks, bridge reamers, hand jointer knives, belt studs, carborundum wheels, etc., as per Circular No. 495.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids on dates as follows: March 9—Leather belting (schedule 961), pneumatic hammers (schedule 960), engine lathes (schedule 945), triple plunger pumps (schedule 946), motors (schedule 951, 970), transformers (schedule 957), turbo-generating sets (schedule 950), bolts and nuts, chains (schedule 954), chucks (schedule 975), forges (schedule 963), hydraulic jacks (schedule 961), steel (schedule 962). March 16—Bolts, chain (schedule 949). March 23—Taps (schedule 953). March 30—Tool grinder (schedule 955).

New Incorporations

The Sharon (Tenn.) Canning Company is being incorporated by W. E. Thomas, S. M. Brock, G. W. Dent, and others.

The Universal Gas Implement Company, Philadelphia, Penn., has been incorporated to manufacture stoves, burners, etc. Capital, $100,000.

The Funk Machine Company, New York, incorporated to manufacture machinery, engines, etc. Capital, $50,000. Incorporators, N. E. Funk, J. B. Wentworth, etc.

The Metal Manufacturing Company, East Orange, N. J., to do forging, rolling, tinning of metals. Capital, $60,000. Incorporators, C. Q. Geyer, F. E. Ruggles, G. G. L. Valle.

Perfection Vacuum Cleaner Company, New York, incorporated with $100,000 capital to manufacture vacuum cleaners. Incorporators, J. S. Montgomery, T. T. Grace, G. O. Grace.

Gordon Bros. Iron Works, Brooklyn, N. Y., has been incorporated to manufacture iron, iron specialties, etc. Capital, $50,000. Incorporators, A. Gordon, S. Gordon, M. Greenberg.

The A. A. Automatic Manufacturing Company, New York, has been incorporated to manufacture electric cooking utensils. Capital, $100,000. Incorporators, A. Aderer, W. M. Lambert, etc.

The Reversible Tin Roofing Company, Mooresville, N. C., has been incorporated to manufacture tin and tin plate. Capital, $100,000. Incorporators, B. A. Troutman, P. S. Torrence, J. W. Brawley.

The Split-Ball Clock Company, Camden, N. J., has been incorporated to manufacture clocks, watches, jewelry, etc. Capital, $100,000. Incorporators, S. M. Stroock, Joseph Singer, Frank A. Kuntz.

The Lightning Horseshoe Tool Company, Pittsburg, Penn., has been incorporated to manufacture blacksmith tools. Capital, $125,000. Incorporators, M. S. Reigh, Joseph Panella, M. J. Davis.

The National Art Metal Company, Danvers, Mass., has been incorporated to manufacture articles from metals, wood, etc. Capital, $100,000. Incorporators, M. M. Merritt, William F. Searle, etc.

Hydrostatic Machinery Company, Rochester N. Y., incorporated to manufacture supplies for plumbers, builders, steam fitters, etc. Capital, $50,000. Incorporators, L. J. Ernest, A. M Spiehler, C. Wheeler.

R. P. K. Pressed Metal Company, Bridgeport, Conn., incorporated to manufacture metal goods, etc. Capital, $50,000. Incorporators, A. L. Ruland, H. M. Kirkland, J. F. Eagle, all of New York City.

E. A. Whitehouse Manufacturing Company, Newark, N. J., incorporated to manufacture saddlery hardware. Capital, $100,000. Incorporators, Ed. A. Whitehouse, F. W. Ehrlick George W. LeCompte.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, Amer. Mach.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Second-hand Pratt & Whitney thread milling machine; must be in good condition. Reply giving full particulars. Box 996, American Machinist.

Users of belting for power transmission to send for free sample of "Belto Cemento." The quickest drying strong belt cement ever produced. C. B. Weaver, Poughkeepsie, N. Y.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, American Machinist.

Lathe, planer and milling machine work, gear cutting, etc., solicited; or machines built complete, by a shop making high-grade machine tools. Estimates furnished. J. F. Bowman, Box 4, Station B, Cincinnati, Ohio.

In order to settle an estate an attractive opportunity is open to a party with $150,000.00, competent to fill responsible position either in the sales or manufacturing department, to purchase an interest in a well and favorably known, profitable machinery manufacturing plant located in Pennsylvania, with an office and established trade in New York City. Address "Executors," care of American Mach.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Mechanical draftsman, 14 years' experience, five of which were spent in the shop, wishes a position. Experience principally on engine and boiler work, stationary and marine. Good recommendations. Box 997, Amer. Machinist.

CONNECTICUT

Experienced machine-tool salesman with wide acquaintance in this country and Europe, wants position with dealer or manufacturer, inside or traveling. Box 6, Am. M.

ILLINOIS

Superintendent or master mechanic, experienced in general manufacturing, at present employed as master mechanic in large manu-

facturing plant. Practical machinist, tool and special machinery designer. Position in or near Chicago preferred. Age 37 years. Unquestionable references. Box 990, AMER. MACH.

INDIANA

Situation wanted as superintendent or general foreman by aggressive and successful manager of men. Interchangeable work. No cure, no pay. Box 8, AMERICAN MACHINIST.

IOWA

Superintendent or general foreman, 25 years' experience in steam and electric hoisting, engines and general machine work. Thoroughly up-to-date in all branches of the business, including drafting, designing and estimating. Good executive and can handle men to advantage. Box 994, AMERICAN MACHINIST.

MASSACHUSETTS

Production superintendent who can reduce costs and increase production in the manufacture of valves, fittings and pipe for power plants. Box 991, AMERICAN MACHINIST.

NEW YORK

Mechanical, electrical designer and patent office draftsman, desires position. Box 4, AMERICAN MACHINIST.

Draftsman, mechanical, experienced detailer and tracer; $15 per week. Spector, 484 Grand St., New York City.

Automobile and gas-engine designer, seven years' experience in this country and abroad, open for engagement. Box 999, AM. MACH.

Graduate from polytechnical university wants position as draftsman; two years' experience on general machinery in Sweden. Box 1, AMERICAN MACHINIST.

Mechanical engineer, 32, designer, shop practice, electrical engineering, comprehensive and varied experience, executive, desires position. Box 998, AMERICAN MACHINIST.

Superintendent of inspection bureau, young man wide experience; will consider a change. Tool, gage or interchangeable parts; good organizer. Box 986, AMERICAN MACHINIST.

Mechanical draftsman, practical and theoretical, technical graduate, wants position; 3 years' experience on machine tools and general machinery. Box 2, AMER. MACHINIST.

Skilled toolmaker, 12 years' experience, inventive patentee of ingenious mechanical device, some experience in tool designing, wishes position with opportunity to continue drafting; moderate salary. Box 7, AMER. MACH.

Designer, graduate mechanical engineer, age 31; on special and automatic machinery, fine instruments, apparatus, tools, fixtures, experimental work. Very able man, inventive; can be depended on for good work in good time. Address Box 995, AMERICAN MACHINIST.

OHIO

Mechanical engineer with experience as designer, chief draftsman and superintendent, wants change. Technical training, shop practice and good executive ability. Prefer company that wants to manufacture pumps, compressors and engines from my design or wants to improve their line. Box 946, AMER. MACH.

PENNSYLVANIA

As general superintendent with large manufacturers or builders of heavy or medium work; replies desired only from those who can use a man of A-1 ability and large experience along these lines. Box 969, AMERICAN MACHINIST.

RHODE ISLAND

By experienced milling machine foreman on light and medium work; capable of designing fixtures, etc., for the rapid handling of work; age 27; married, temperate. Box 5, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Thoroughly up-to-date first-class man to set piece work prices in a large electrical factory in Canada. Applicant must state experience in this line as well as other lines and references; also salary required. None but first class men need apply. Box 972, AM. MA.

ILLINOIS

Technical graduate wanted for position of senior draftsman by concern manufacturing elevating, conveying and power transmitting machinery. Executive ability essential and knowledge of light structural steel work desirable. Give nationality, age, experience, references and salary expected in first letter. Address "Ramsay," care AMERICAN MACHINIST.

INDIANA

Wanted—4 toolmakers, 6 lathe men, 1 foreman. Good wages, steady employment. Box 943, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—A toolroom foreman thoroughly experienced in toolmaking and in modern toolroom methods. Must have first-class executive ability. Old established manufacturing concern in suburb of Boston, Mass. Open shop. None but experienced high grade foremen need apply. "Foreman," Box 3536, Boston.

NEW JERSEY

Strictly first-class mechanical draftsman wanted; one with experience gained in large steelworks and who is able to design from preliminaries submitted. Give references and state nationality, age, training, etc. "Capable," care AMERICAN MACHINIST.

Salesman—A traveling salesman who is now selling the machine or railroad supply trade, to carry a high grade bearing metal (babbitt) as a side line, on liberal commission basis. Address, with full particulars, Lakewood Metal Co., Box 182, Lakewood, N. J.

In our rapidly growing business of the manufacture of a well known article, we always have openings for draftsmen and toolmakers on small tools, jigs, sub-press dies and special machinery. We invite applications from first-class men on this kind of work. Box 884, AMERICAN MACHINIST.

NEW YORK

Toolmaker Wanted—First-class man, familiar with small dies and tools. State age and salary; also class of work accustomed to. Address the Meyrowitz Mfg. Co., 31st St. and 1st Ave., New York.

Wanted—A draftsman with experience in making patent office drawings; familiar with electrical work; steady position with reliable concern in New York City. State age, experience and salary expected. Box 3, AM. M.

Wanted—First-class designers on automatic machinery. Apply by letter, giving detailed information of experience, salary expected and references. Hanford & Barkley, machinery designers, No. 412 German Ins. Bld'g., Rochester, N. Y.

Assistant foreman for milling department of large plant manufacturing small interchangeable parts; location, central New York. Must be a good executive and thoroughly familiar with up-to-date milling machine practice. Box 992, AMERICAN MACHINIST.

Chief draftsman; we want a man who has had extensive experience on both small and large work along the line of motors, generators and other electrical machinery. He should be a good executive and thoroughly up-to-date. Write in confidence, giving full information, age and salary expected. Box 959, AMERICAN MACHINIST.

Superintendent wanted in Brooklyn factory. A progressive man who has made good in similar position. Must be thorough mechanic, familiar with modern methods, able to organize and handle men and show results. Applications must contain full particulars as to experience, references and salary to receive consideration. "Confidential," AMERICAN MACHINIST.

Machinery Specialty Salesman — First-class man wanted to visit large corporations, factories and mill supply dealers to build up sales of well established machinery specialty used universally. The right man, qualified to educate dealers' salesmen, can have permanent position at good salary with strong well known eastern manufacturing company. State age, experience, references and salary expected. Address "Well Known," care the AMERICAN MACHINIST.

OHIO

Wanted—Foreman for machine shop employing 25 hands; building new and rebuilding paper mill machinery. One familiar with this class of work preferred. We also prefer a young married man. Salary, $100.00 per month. Address Shartle Bros. Machine Co., Middletown, Ohio.

General foreman for machine room employing about 100 men on automobile work in northern Ohio. Man must have had experience with piece work plan and must be capable of turning the work out quickly and cheaply. None but those holding down similar positions at the present time need apply. Box 989, AM. MA.

PENNSYLVANIA

Wanted—Machinists to make levels—good proposition. E. G. Smith, Columbia, Pa.

Wanted—An expert reamer grinder. Box 987, AMERICAN MACHINIST.

Wanted—Capable, energetic man as master mechanic. Must be experienced with Corliss engine and electric cranes. Box 988, AM. MA

Wanted—First-class, energetic foreman, to take charge of machine shop employing 100 men, on light and medium heavy special machinery. State age, experience, salary expected, references and when you can start work. Box 950, AMERICAN MACHINIST.

Draftsman—An Eastern college has a position open for a technical graduate as junior instructor of mechanical drawing. Applicant must have some drawing office experience. Give age, education, experience with references and salary expected. Box 993, AMER. MACH.

Wanted—A competent shop manager who is practical enough to secure maximum production at minimum cost, and who has sufficient business capacity to manage office and handle finances of a company doing $250,000 business annually. All replies treated strictly confidential. Box 984, AMER. MACHINIST.

Wanted—Chief draftsman of good designing ability. A first-class man with wide experience covering hoisting engines and general machinery, boiler and steam plants. Prefer a man with college education and of good executive ability. Good salary to a first-class man. In replying state experience and age, giving full particulars. Box 956, AMERICAN MACH.

RHODE ISLAND

Wanted—By cotton machine builders, energetic, reliable, practical man, who understands cotton spinning and manufacturing; one preferred with good technical education who has had experience as master mechanic and thoroughly understands power plants and electricity. Box 973, AMERICAN MACHINIST.

For Sale

Valuable Canadian Patent—On labor-saving machine being rapidly introduced in the United States. Reynolds Machine Co., Moline, Ill.

Patents for sale of heavy machine tools well introduced or owner will take part cash, royalty or stock in a company of responsibility. Box 942, AMERICAN MACHINIST.

For Sale—Fine machine shop equipment, consisting of Garvin milling machine, drill press, shaper bench lathe, Hendy Norton 16" engine lathe, 20" Hoefer drill press, Garvin hand screw machine and a large number of small tools. Address E. Allen, 905 N. Winnebago St., Rockford, Ill.

For Sale—A first-class marine engine business, established two years, with a large number of engines in use all over the country. Present inventory $2,200.00, also, a large correspondence. Will sell at a great reduction, owing to the present owner's extensive automobile business. Further information furnished on application. Box 985, AMERICAN MACHINIST.

English factory for sale covering about 6500 square yards and additional 10,000 square yards for extensions. 130 horsepower gas engines and up-to-date machinery, suitable for light manufacturing work of any kind. Factory situated in largest manufacturing center of the Midlands. Owners are open to manufacture and distribute under direct supervision large quantities of patented articles. Hill, Cawney House, Dudley, Worcestershire, England.

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